NASA CONTRACTOR
REPORT

NASA CR-129006

NASA-CR-129006) NASA/MSFC MULTILAYER DIFFUSION MODELS AND COMPUTER PROGRAM FOR OPERATIONAL PREDICTION OF TOXIC FUEL (Cramer (H.E.) Co., Inc., Salt Lake City, Utah.) ~~293~~ 297 p HC $16.75 CSCL 09B   N73-28050

G3/08   Unclas 1.495

NASA/MSFC MULTILAYER DIFFUSION MODELS AND COMPUTER PROGRAM FOR OPERATIONAL PREDICTION OF TOXIC FUEL HAZARDS

By R. K. Dumbauld, J. R. Bjorklund, and J. F. Bowers
H. E. Cramer Company, Inc.
P. O. Box 9249
Salt Lake City, Utah 84109

June 1973

Prepared for

NASA-GEORGE C. MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, Alabama 35812

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. NASA CR-129006	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE NASA/MSFC Multilayer Diffusion Models and Computer Program for Operational Prediction of Toxic Fuel Hazards		5. REPORT DATE JUNE 1973
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) R. K. Dumbauld, J. R. Bjorklund, and J. F. Bowers		8. PERFORMING ORGANIZATION REPORT #
9. PERFORMING ORGANIZATION NAME AND ADDRESS H. E. Cramer Company, Inc. P. O. Box 9249 Salt Lake City, Utah 84109		10. WORK UNIT NO.
		11. CONTRACT OR GRANT NO. NAS 8-29033
		13. TYPE OF REPORT & PERIOD COVERED Contractor Report
12. SPONSORING AGENCY NAME AND ADDRESS George C. Marshall Space Flight Center National Aeronautics and Space Administration Marshall Space Flight Center, Alabama 35812		
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Prepared under the technical monitorship of the Aerospace Environment Division, Aero-Astrodynamics Laboratory, NASA-Marshall Space Flight Center.

16. ABSTRACT

This report describes the NASA/MSFC Multilayer Diffusion Models used in applying meteorological information to the estimation of toxic fuel hazards resulting from the launch of rocket vehicle and from accidental cold spills and leaks of toxic fuels.

The main body of the report contains five sections. Section 1 includes background information, the purpose of the report, and a definition of terms used in the report. Section 2 contains a description of the generalized concentration and dosage models which form the basis of the multilayer concept. Formulas for determining the buoyant rise of hot exhaust clouds or plumes from conflagrations, necessary for specifying model input parameters, are given in Section 3. Section 4 contains a description of the multilayer diffusion models and lists the mathematical formulas forming the basis of the computer program. A brief description of the computer program is given in Section 5. Finally, Section 6 contains some sample problems and their solutions obtained using the computer program.

There are five appendices to the report. Appendix A contains derivations of the cloud rise formulas described in Section 3. Appendix B contains users instructions for the computer program; and Appendix D contains example computer program output listings. Meteorological and source inputs used in the examples described in Section 6 of the report are contained in tables presented in Appendix E.

17. KEY WORDS Atmospheric Diffusion; Multilayer Diffusion Model; Exhaust Cloud Rise; Rocket Motor Exhaust Diffusion	18. DISTRIBUTION STATEMENT Unclassified-unlimited E. D. Geissler E. D. Geissler Director, Aero-Astrodynamics Laboratory

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
UNCLASSIFIED	UNCLASSIFIED	298	NTIS

MSFC - Form 3292 (May 1969)

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FOREWORD

This report is submitted to the Aerospace Environment Division, Aero-Astrodynamics Laboratory, NASA-Marshall Space Flight Center, Alabama in partial fulfillment of requirements under Contract No. NAS8-29033. The purpose of this report is to document revisions to the NASA Handbook for Estimating Toxic Fuel Hazards (Dumbauld, et al., 1970) and, in particular, the computer program associated with the Handbook. As experience has been gained in the application of the NASA/MSFC Multilayer Diffusion Model Program, it has become apparent that the program input requirements should be simplified for more efficient use of the multilayer concept. This report consists of:

- A description of the mathematical specifications for the NASA/MSFC Multilayer Diffusion Models
- Procedures for obtaining and calculating meteorological and source inputs to the revised diffusion model computer program
- A description of the revised NASA/MSFC Multilayer Diffusion Model Program
- A usage manual for implementing the revised NASA/MSFC Multilayer Diffusion Model Program
- Worked example problems illustrating the use of the diffusion models and computer program

The H. E. Cramer Company, Inc. is indebted to Dr. Leonard DeVries, Mr. John Kaufman and Mr. Charles Hill, Environmental Hazards Group, Aerospace Environment Division for their guidance in planning the revisions to the NASA

Handbook for Estimating Toxic Fuel Hazards. Mr. Archie Jackson, NASA/MSFC Computation Laboratory, NASA-Marshall Space Flight Center, also provided suggestions for revising the procedures for entering input data into the NASA/MSFC Multilayer Diffusion Model Program.

Staff members of the H. E. Cramer Company, Inc. making important contributions to this report are Dr. J. E. Faulkner, Mr. H. V. Geary and Mrs. G. H. Hansen. The work under this contract is under the direction of Dr. Harrison E. Cramer.

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SECTION 1
INTRODUCTION

1.1 BACKGROUND

The use of mathematical prediction models in applying meteorological information to the estimation of toxic fuel hazards is mandatory because of the inherent scarcity and fragmentary nature of measurements of the behavior of toxic clouds resulting from NASA operations. The concept of developing generalized dosage and concentration models for use in hazard estimation for a variety of environmental situations and for a variety of source configurations was originally developed and implemented for the U. S. Army (Cramer, et al., 1964; 1967; Cramer and Dumbauld, 1968). The concept was adapted to the prediction of environmental hazards from NASA operations by Record, et al. (1970) and Dumbauld, et al. (1970). This work under two concurrent NASA contracts (Contract Nos. NAS8-21453 and NAS8-30503) resulted in the publication of the NASA Handbook for Estimating Toxic Fuel Hazards and included a computer program specifically designed for research-oriented projects and for use in hazard estimation. The program was designed to permit hazard calculations downwind from normal and abnormal launches of rocket vehicles and from accidental cold spills and leaks of toxic fuels. The hazard estimation procedures and computer program developed under the above contracts have subsequently found wide use in estimation of hazards associated with vehicle launches and launch aborts (Cramer, et al., 1970; Dumbauld and Bjorklund, 1971; Cramer, et al., 1971; Cramer, et al., 1972a; 1972b; Dumbauld and Bjorklund, 1972).

1.2 PURPOSE

As experience has been gained in the application of the NASA/MSFC Multilayer Diffusion Model Program, it has become apparent that some revisions to the

original program design could be made to simplify the use of the program while retaining its overall flexibility in application to a variety of hazard problems. The purpose of this report is to document the simplifications made in the computer program.

The majority of the revisions entailed a streamlining of data input requirements and procedures used to enter data into the program. In the new version of the program, all source and meteorological data inputs required by the dispersion-transport models are entered into the program using a FORTRAN NAMELIST format. The ISKIP options used to control program options in the original program have been considerably simplified. In addition, requirements for duplicate entries of some meteorological inputs in the original version of the program have been eliminated and some parameters need not be entered unless changes in preset values are required.

The original program contained seven versions of the basic diffusion models, labeled Model 1 to Model 7. Each version was applicable to a specific type of problem. Some of the original seven model versions have been eliminated because experience has shown them to be of limited use in hazard estimation. Others have been revised. A complete description of the revised versions of the basic diffusion models is included in this report.

1.3 DEFINITION OF TERMS USED IN THE REPORT

The terminology used in this report conforms, in general, with the standard nomenclature of diffusion meteorology. Concentration refers to the mass of a pollutant per unit volume at a point, but it may be referenced to the ambient atmosphere, as in parts per million. Dosage is the time-integrated concentration at a point and has the units of concentration multiplied by unit time (for example, milligram-seconds per cubic meter or parts per million-seconds). This definition of dosage, which conforms to the terminology of the U. S. Army, does not include physiological factors such as the respiration rate of a receptor. Some agencies, notably the U. S. Air Force, use

the term exposure to refer to the time-integrated concentration. The concentration and dosage terms used in this report are defined as follows:

- The maximum concentration $\chi\{x, y, z\}$ at a point (x, y, z) is the maximum concentration in time that occurs at the point
- The dosage $D\{x, y, z\}$ is the time-integrated concentration at the point (x, y, z)
- The maximum centerline concentration $\chi_c\{x, y=0, z\}$ is the maximum concentration in time in the plane of the horizon at the downwind distance x and the height above the ground z
- The average alongwind concentration $\overline{\chi}\{x, y, z\}$ is the time-integrated concentration (dosage) at the point (x, y, z) averaged over the cloud passage time
- The time-mean alongwind concentration $\chi\{x, y, z; T_A\}$ is the partial dosage from time $ta - T_A/2$ to time $ta + T_A/2$ averaged over the time T_A, where ta is the arrival time of the cloud centroid at downwind distance x; for cloud passage times of less than T_A, $\chi\{x, y, z; T_A\}$ is then the total dosage averaged over T_A
- The centerline dosage $D_c\{x, y=0, z\}$ is the maximum dosage in the plane of the horizon at the downwind distance x and the height z

1.4 ORGANIZATION OF THE REPORT

The main body of the report contains five sections. Section 2 contains a description of the generalized concentration and dosage models which form the

basis of the multilayer concept. Formulas for determining the buoyant rise of hot exhaust clouds or plumes from conflagrations, necessary for specifying model input parameters, are given in Section 3. Section 4 contains a description of the multilayer diffusion models and lists the mathematical formulas forming the basis of the computer program. A brief description of the computer program is given in Section 5. Finally, Section 6 contains some sample problems and their solutions obtained using the computer program.

There are five appendices to the report. Appendix A contains derivations of the cloud rise formulas described in Section 3. Appendix B contains users instructions for the computer program; Appendix C contains a complete listing of the computer program; and Appendix D contains example computer program output listings. Meteorological and source inputs used in the examples described in Section 6 of the report are contained in tables presented in Appendix E.

SECTION 2

GENERALIZED CONCENTRATION AND DOSAGE MODELS

The generalized models developed under the previous Government contracts described in Section 1 are presented here because they form the basis of the computerized NASA/MSFC multilayer diffusion models and computer program described in Sections 4 and 5 below. Generalized models are given for nearly-instantaneous releases in which the cloud of toxic material is detached from the source after a few seconds or, at the most, a few minutes. This condition is typical of normal and abnormal launches. Adaptation of the generalized models to continuous source emissions resulting from cold fuel spills and fuel leaks is outlined at the end of this section.

2.1 GENERALIZED CONCENTRATION MODEL

The generalized concentration model is expressed as the product of five modular terms:

$$\text{Concentration} = \{\text{Peak Concentration Term}\} \times \{\text{Alongwind Term}\} \times \{\text{Lateral Term}\} \times \{\text{Vertical Term}\} \times \{\text{Depletion Term}\}$$

The mathematical formulas given below for the various terms are written according to conventional usage. Specifically, the concentration model is referred to a Cartesian coordinate system with the origin at $x = 0$, $y = 0$ and $z = 0$ with the source located at an effective height H above the origin. The direction of x is along the mean azimuth wind direction, y is normal to the mean wind direction in the plane of the horizon, and z is directed vertically with $z = 0$ at ground level. The distribution of concentration along each of the three coordinate axes is assumed to be Gaussian. None of the above assumptions is required. The model equations are easily transformed to a polar coordinate system or other systems, and other distribution functions may be substituted for the Gaussian function.

The Peak Concentration Term refers to the concentration at the point x, y = 0, z = H and is defined by the expression

$$\frac{Q}{(2\pi)^{3/2}\ \sigma_x \sigma_y \sigma_z}$$

where

Q = source strength

σ_x = standard deviation of the alongwind concentration distribution

σ_y = standard deviation of the crosswind concentration distribution

σ_z = standard deviation of the vertical concentration distribution

The Alongwind Term is defined by the expression

$$\exp\left[-\frac{1}{2}\left(\frac{x-\bar{u}t}{\sigma_x}\right)^2\right] \tag{2-2}$$

where

$\bar{u}$ = mean wind speed

t = time of cloud travel

The Lateral Term is defined by the expression

$$\exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right] \tag{2-3}$$

The Vertical Term is given by the expression

$$\exp\left[-\frac{1}{2}\left(\frac{H-z}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{H+z}{\sigma_z}\right)^2\right] + \sum_{i=1}^{\infty}\left\{\exp\left[-\frac{1}{2}\left(\frac{2iH_m-H-z}{\sigma_z}\right)^2\right]\right.$$

$$\left. + \exp\left[-\frac{1}{2}\left(\frac{2iH_m-H+z}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{2iH_m+H-z}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{2iH_m+H+z}{\sigma_z}\right)^2\right]\right\} \tag{2-4}$$

where

H = effective source height

H_m = height of the top of the mixing layer

The multiple reflection terms following the summation sign stop the vertical cloud growth at the top of the mixing layer and eventually change the form of the vertical concentration distribution from Gaussian to rectangular.

The Depletion Term refers to the loss of material by simple decay processes, precipitation scavenging, or gravitational settling. The form of the Depletion Term for each of these processes is:

(Decay) $\exp\left[-kt\right]$ (2-5)

(Precipitation Scavenging) $\exp\left[-\Lambda t\right]$ (2-6)

(Gravitational Settling)

$$\exp\left[-\frac{1}{2}\left(\frac{H-\left(V_s x/\bar{u}\right)-z}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{2H_m-H+\left(V_s x/\bar{u}\right)-z}{\sigma_z}\right)^2\right] \tag{2-7}$$

where

k = decay coefficient or fraction of material lost per unit time

t = time

Λ = washout coefficient or fraction of material removed by scavenging per unit time

V_s = settling velocity

When Equation (2-7) is used for the Depletion Term, the Vertical Term given by Equation (2-4) is set equal to unity. This causes the cloud axis to be inclined downward at the angle $\tan^{-1}(V_s/\bar{u})$ with respect to the horizon, following W. Schmidt's sedimentation hypothesis (see Pasquill, 1962, p. 226); material that deposits on the ground surface is retained and not reflected. The vertical growth of the cloud is stopped at the top of the mixing layer and reflected toward the ground by the second exponential term in Equation (2-7). The depletion by gravitational settling of material containing a size distribution is calculated by partitioning the distribution into various settling-velocity categories, solving Equation (2-7) for each settling velocity, and superposing the solutions.

2.2 GENERALIZED DOSAGE MODEL

The generalized dosage model is similar in form to the generalized concentration model and is defined by the product of four modular terms:

$$\text{Dosage} = \{\text{Peak Dosage Term}\} \times \{\text{Lateral Term}\} \times \{\text{Vertical Term}\} \times \{\text{Depletion Term}\}$$

The Peak Dosage Term is given by the expression

$$\frac{Q}{2\pi\,\bar{u}\,\sigma_y\,\sigma_z} \tag{2-8}$$

where

Q = source strength

$\bar{u}$ = mean wind speed

σ_y = standard deviation of the crosswind dosage distribution

σ_z = standard deviation of the vertical dosage distribution

The remaining terms in the generalized dosage model are defined in the same manner as the corresponding terms for the generalized concentration model which are given by Equations (2-3), (2-4), (2-5), (2-6) and (2-7).

2.3 SUBSET OF EQUATIONS FOR σ_y, σ_z AND σ_x

The following subset of equations is used to define the distance dependence of the standard deviations of the crosswind, vertical and alongwind distributions in the generalized concentration and dosage models described above:

$$\sigma_y\{x\} = \left\{\left[\sigma'_A\{\tau\}\, x_{ry}\left(\frac{x+x_y-x_{ry}(1-\alpha)}{\alpha x_{ry}}\right)^{\alpha}\right]^2 + \left[\frac{\Delta\theta' x}{4.3}\right]^2\right\}^{1/2} \tag{2-9}$$

where

$\sigma'_A\{\tau\}$ = standard deviation of the azimuth wind angle in radians for the cloud stabilization time τ

x_{ry} = distance over which rectilinear crosswind expansion occurs downwind from an ideal point source

x_y = virtual distance

$$= \begin{cases} \dfrac{\sigma_{yo}}{\sigma'_A\{\tau\}} - x_{Ry} & ; \ \sigma_{yo} \le \sigma'_A\{\tau\}\, x_{ry} \\[2ex] \alpha x_{ry}\left(\dfrac{\sigma_{yo}}{\sigma'_A\{\tau\}\, x_{ry}}\right)^{1/\alpha} - x_{Ry} + x_{ry}(1-\alpha) & ; \ \sigma_{yo} \ge \sigma'_A\{\tau\}\, x_{ry} \end{cases}$$

σ_{yo} = standard deviation of the crosswind distribution at x_{Ry}

x_{Ry} = distance from the source at which σ_{yo} is measured

α = lateral diffusion coefficient of the order of unity

$\Delta\theta'$ = azimuth wind direction shear in radians within the layer containing the cloud

$$\sigma_z\{x\} = \sigma'_E\, x_{rz}\left(\frac{x+x_z-x_{rz}(1-\beta)}{\beta\, x_{rz}}\right)^{\beta} \qquad (2\text{-}10)$$

where

σ'_E = standard deviation of the wind elevation angle in radians at height H

x_{rz} = distance over which rectilinear vertical expansion occurs

x_z = virtual distance

$$= \left\{\begin{array}{ll} \dfrac{\sigma_{zo}}{\sigma'_E} - x_{Rz} & ;\ \sigma_{zo} \le \sigma'_E\, x_{rz} \\[2ex] \beta x_{rz}\left(\dfrac{\sigma_{zo}}{\sigma'_E\, x_{rz}}\right)^{1/\beta} - x_{Rz} + x_{rz}(1-\beta) & ;\ \sigma_{zo} \ge \sigma'_E\, x_{rz} \end{array}\right\}$$

σ_{zo} = standard deviation of the vertical distribution at x_{Rz}

x_{Rz} = distance from the source at which σ_{zo} is measured

β = vertical diffusion coefficient of the order of unity

$$\sigma_x\{x\} = \left[\left(\frac{L\{x\}}{4.3}\right)^2 + \sigma_{xo}^{\ 2}\right]^{1/2} \qquad (2\text{-}11)$$

where

$L\{x\}$ = alongwind cloud length of a point source when the center of the cloud is a distance x from the source

$$= \frac{0.28\,(\Delta u)\,(x)}{\bar{u}}$$

Δu = wind speed shear within the layer containing the cloud

σ_{xo} = standard deviation of the alongwind distribution at the source

In Equation (2-9) above, σ'_A is expressed as a function of time τ where τ is the time after release required for the cloud to reach equilibrium with ambient atmospheric conditions. Values of σ'_A for nearly-instantaneous releases are difficult to measure directly, but can be calculated from the following semi-empirical relationship (Cramer, et al., 1964):

$$\sigma'_A\{\tau\} = \sigma'_A\{\tau_o\}\left(\frac{\tau}{\tau_o}\right)^{1/5} \tag{2-12}$$

where τ_o is $\leq$ 10 minutes. The standard deviation of the wind elevation angle σ'_E is assumed independent of the release time τ because of the relatively narrow frequency range in the power spectrum of the vertical wind velocity component that contains significant amounts of turbulent energy. This assumption is generally valid at heights $\leq$ 100 meters above the ground surface. In the presence of large convective cells and at heights of the order of 1 kilometer, the assumption that σ'_E is independent of τ likely does not hold. However, the effect on the accuracy of ground-level concentration and dosage estimates is thought to be slight.

The source dimensions σ_{xo}, σ_{yo}, σ_{zo} in the above subset refer to a stabilized cloud at time τ. These source dimensions are best estimated from direct measurements or observations. The virtual distances x_y, x_z are used to adjust the lateral and vertical terms of the generalized models for the initial source dimensions σ_{yo} and σ_{zo}. Two virtual distances are employed to facilitate the treatment of asymmetrical sources where $\sigma_{yo} \neq \sigma_{zo}$. In applications, x_y and x_z are constrained to be positive. The height of the stabilized cloud above ground level, when the emission mode is accompanied by the release of significant amounts of thermal energy, must be estimated from observations or by means of a mathematical formula for buoyant plume rise such as those given in Section 3 below.

2.4 MODEL FORMULAS FOR GROUND DEPOSITION CAUSED BY PRECIPITATION SCAVENGING AND GRAVITATIONAL SETTLING

The total amount of material deposited on the ground surface by precipitation scavenging, at some distance x, is given by the expression

$$\frac{\Lambda Q}{\sqrt{2\pi}\,\sigma_y\,\bar{u}} \left\{ \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2 \right] \right\} \left\{ \exp\left[-\Lambda\left(\frac{x}{\bar{u}} - t_1\right) \right] \right\} \qquad (2\text{-}13)$$

where t_1 is the time at which the precipitation begins. The principal assumptions made in deriving the above expression are:

- The rate of precipitation is steady over an area that is large compared to the horizontal dimension of the cloud of toxic material

- The precipitation originates at a level above the top of the toxic cloud so that hydrometeors pass vertically through the entire cloud

- The time duration of the precipitation is sufficiently long so that the entire alongwind length of the toxic cloud passes over the point x

Engelmann (see Slade, 1968, pp. 208-221) discusses the general problems of calculating the amount of material removed by precipitation scavenging and recommends values of the coefficient Λ that may be combined with precipitation rates to obtain estimates of total surface deposition. Other useful information may be obtained from the proceedings of the 1970 Symposium on Precipitation Scavenging (Engelmann and Slinn, 1970).

The total deposition due to the gravitational settling of heavy particles or droplets with settling velocity V_s, at a downwind distance x from the source and on the projection of the alongwind cloud axis on the ground plane, is given by the expression

$$\frac{Q}{\sqrt{2\pi}\,\sigma_y}\ \frac{d}{dx}\left\{\frac{1}{\sqrt{2\pi}\,\sigma_z}\int_{-\infty}^{o}\left\{\exp\left[-\frac{1}{2}\left(\frac{H-\left(V_s x/\bar{u}\right)-z}{\sigma_z}\right)^2\right]\right.\right.$$

$$\left.\left.+\ \exp\left[-\frac{1}{2}\left(\frac{2H_m-H+\left(V_s x/\bar{u}\right)-z}{\sigma_z}\right)^2\right]\right\}dz\right\} \tag{2-14}$$

After the integration and differentiation are performed, the above expression becomes

$$\frac{Q}{2\pi\,\sigma_y}\left\{\left[\frac{\beta H+\left(1-\left(\frac{\beta x}{x+x_z-x_{rz}(1-\beta)}\right)\right)V_s\left(x+x_z-x_{rz}(1-\beta)\right)/\bar{u}}{\sigma_z\left(x+x_z-x_r(1-\beta)\right)}\right]\exp\left[-\frac{1}{2}\left(\frac{H-\left(V_s x/\bar{u}\right)}{\sigma_z}\right)^2\right]\right.$$

$$+\left[\frac{\beta\left(2H_m-H\right)-\left(1-\left(\frac{\beta x}{x+x_z-x_{rz}(1-\beta)}\right)\right)V_s\left(x-x_z-x_{rz}(1-\beta)\right)/\bar{u}}{\sigma_z\left(x+x_z-x_{rz}(1-\beta)\right)}\right] \tag{2-15}$$

$$\left.\exp\left[-\frac{1}{2}\left(\frac{2H_m-H+\left(V_s x/\bar{u}\right)}{\sigma_z}\right)^2\right]\right\}$$

2.5 ADAPTATION OF THE GENERALIZED MODELS TO CONTINUOUS SOURCE EMISSIONS

The generalized concentration and dosage models discussed in Sections 2.1 and 2.2 above are applicable to cases in which the source is nearly-instantaneous.

Treatment of cold spills and fuel leaks that occur near ground level requires that these models be adapted for use in predicting concentrations downwind from continuous sources.

The generalized concentration model for continuous source emission is given by the product of four terms

$$\text{Concentration} = \{\text{Peak Concentration}\} \times \{\text{Lateral Term}\} \times \{\text{Vertical Term}\} \times \{\text{Depletion Term}\}$$

The Peak Concentration Term is given by the expression

$$\frac{Q}{2\pi \, \bar{u} \, \sigma_y \, \sigma_z} \qquad (2\text{-}16)$$

where

Q = source strength in units of total mass released per unit time

$\bar{u}$ = mean wind speed at the effective source height

σ_y = standard deviation of the crosswind concentration distribution

σ_z = standard deviation of the vertical concentration distribution

The Lateral Term, Vertical Term and the subset of equations defining σ_y and σ_z are respectively given by Equations (2-3), (2-4), (2-9) and (2-10). The Depletion Term is given by Equations (2-5), (2-6) and (2-7), depending on the depletion mechanism. The expression for the Peak Concentration Term given by Equation (2-16) is very similar to the Peak Dosage Term in Equation (2-8) except for the definition of source strength and the mean wind speed.

SECTION 3

CLOUD RISE FORMULAS

The burning of rocket engines during normal launches and on-pad aborts results in the formation of a cloud of hot exhaust products which subsequently rises and entrains ambient air until an equilibrium with ambient conditions is reached. For normal launches, this cloud is formed principally by the forced ascent of hot turbulent exhaust products that have been deflected laterally and vertically by the launch pad hardware and the ground surface. The height at which this ground cloud stabilizes (i.e., reaches equilibrium with the environment) is determined by the vehicle type and atmospheric stability. The residence time of the vehicle on the pad appears to determine which type of cloud-rise formula is appropriate for predicting the stabilization height. Experience to date indicates that the buoyant rise of exhaust clouds from normal launches of solid-fueled and small liquid-fueled vehicles is best predicted by using a cloud rise model for instantaneous sources; the cloud rise for large liquid-fueled vehicles is best predicted by the use of a cloud rise model for continuous sources. While no cloud rise data are available for on-pad aborts, cloud rise data from static tests of liquid-fueled rockets indicate that the use of a cloud rise model for continuous sources is appropriate in this case.

3.1 CLOUD RISE FORMULAS FOR INSTANTANEOUS SOURCES

The following formulas for the maximum buoyant rise of clouds from instantaneous sources are based on procedures similar to those contained in a preprint of a paper presented by G. A. Briggs (1970) at the Second International Clean Air Congress. Derivations of these plume rise formulas are contained in Appendix A.

3.1.1 Adiabatic Atmosphere

The maximum cloud rise z_{mI} downwind from an instantaneous source in an adiabatic atmosphere (potential temperature constant with height) is given by

$$z_{mI} = \left[\frac{2\, F_I\, t_{sI}^2}{\gamma_I^3} + \left(\frac{r_R}{\gamma_I} \right)^4 \right]^{1/4} - \frac{r_R}{\gamma_I} \tag{3-1}$$

where

F_I = the buoyancy parameter

$$= \frac{3g\, Q_I}{4\pi\, \rho\, c_p\, T} \tag{3-2}$$

g = acceleration due to gravity (m sec^{-2})

Q_I = the effective heat released (cal)

c_p = specific height of air at constant pressure (cal $gm^{-1}\ {}^{o}K^{-1}$)

T = ambient air temperature (${}^{o}K$)

ρ = density of ambient air (gm m^{-3})

γ_I = the entrainment coefficient for an instantaneous source

r_R = the initial cloud radius at the surface (m)

t_{sI} = the time required for the cloud to reach stabilization (sec)

3.1.2 Stable Atmosphere

The maximum cloud rise z_{mI} downwind from an instantaneous source in a stable atmosphere is given by

$$z_{mI} = \left[\frac{8F_I}{\gamma_I^3\, s} + \left(\frac{r_R}{\gamma_I} \right)^4 \right]^{1/4} - \frac{r_R}{\gamma_I} \tag{3-3}$$

where

$$s = \frac{g}{T}\frac{\partial\Phi}{\partial z} \approx \frac{g}{T}\frac{\Delta\Phi}{\Delta z}$$

$\frac{\Delta\Phi}{\Delta z}$ = the vertical gradient of ambient potential temperature

Equations (3-1) and (3-3) assume that the initial upward momentum imparted to the exhaust gases by reflection from the ground surface and launch pad hardware is insignificant in comparison with the effect of thermal buoyancy. Based on limited experience in predicting cloud rise from launches at Vandenberg Air Force Base, this assumption appears to be justified.

3.2 CLOUD RISE FORMULAS FOR CONTINUOUS SOURCES

The following formulas for the maximum buoyant rise of clouds from continuous sources are also based on procedures similar to those given by Briggs (1970). The derivations of these formulas are given in Appendix A.

3.2.1 Adiabatic Atmosphere

The maximum cloud rise z_{mc} downwind from a continuous source in an adiabatic atmosphere is given by

$$z_{mc} = \left[\frac{3 F_c x_{sc}^2}{2\gamma_c^2 \bar{u}^3} + \left(\frac{r_R}{\gamma_c}\right)^3\right]^{1/3} - \frac{r_R}{\gamma_c} \tag{3-4}$$

where

F_c = the buoyancy flux parameter

$$= \frac{g Q_c}{\pi \rho c_p T} \tag{3-5}$$

Q_c = the effective rate of heat release (cal sec^{-1})

γ_c = the entrainment coefficient for a continuous source

$\bar{u}$ = the mean wind speed (m sec^{-1})

x_{sc} = the downwind distance at which the cloud reaches its stabilization height (m)

3.2.2 Stable Atmosphere

The maximum cloud rise z_{mc} downwind from a continuous source in a stable atmosphere is given by

$$z_{mc} = \left[\frac{6\, F_c}{\bar{u}\, \gamma_c^2\, s} + \left(\frac{r_R}{\gamma_c} \right)^3 \right]^{1/3} - \frac{r_R}{\gamma_c} \qquad (3\text{-}6)$$

Equations (3-4) and (3-6) assume that the initial momentum flux imparted to the cloud by dynamic forces is negligible in comparison with the buoyancy flux. Again, experience in calculating cloud rise for normal launches of large liquid fueled rockets and for static firings has shown that this assumption is reasonable.

SECTION 4

THE NASA/MSFC MULTILAYER DIFFUSION MODEL

4.1 THE MULTILAYER CONCEPT

The meteorological structure in the low-level reference air volume (from the surface to a height of about 5 kilometers) is usually comprised of several layers with distinctive wind, temperature and humidity fields. Large horizontal spatial variations in wind regimes may also occur in the surface layer, usually as a consequence of changes in terrain or land-water interfaces. The generalized diffusion models described in Section 2 have been adapted to these variations in meteorological structure. The vertical stratification problem in the reference volume is handled by applying the models to individual layers in which the meteorological structure is reasonably homogenous. Layer boundaries are placed at the points of major discontinuities in the vertical profiles of wind, temperature, and humidity. For simplicity, it is assumed that there is no flux of material across layer boundaries due to turbulent mixing. Provision is made, however, for the flux of material across layer boundaries as a result of gravitational settling or precipitation scavenging.

Step changes in the meteorological structure of layers, at some arbitrary time or downwind distance from the point of release, are accommodated by stopping the transport and diffusion processes in the layers affected by the change in structure, calculating new sets of initial source and meteorological model input parameters, and re-starting the transport and diffusion process with the new inputs. The model provisions for step changes in meteorological structure can also be used to account for the vertical distribution of material within the stabilized cloud. The use of this feature of the program is further explained in Section 4.5 below.

Two geometries are involved in the multilayer concepts outlined above. The first is the layer geometry used with the Cartesian coordinate system of the generalized models in which the x-axis is along the mean wind direction in the layer. The second geometry refers to a basic reference polar coordinate grid system used in the computer program for the calculation of concentration and dosage fields.

The above concepts have been used to develop a multilayer construct, based on the generalized diffusion models, for application to the toxic fuel hazard problem at NASA installations. Mathematical specifications for the various layer models used in the NASA/MSFC multilayer construct are given below. These specifications provide the foundation for the computer programs that constitute the principal methods for estimating toxic fuel hazards. The six layer models first described refer principally to the transport, dispersal and depletion of toxic material formed as the result of normal and abnormal launches. The use of the multilayer diffusion program for estimating concentration fields downwind from cold fuel spills and surface fuel leaks is described at the end of the section.

4.2 MODEL 1

In this layer model, the source extends vertically through the entire layer and turbulent mixing is occurring. It is assumed that the vertical distribution of toxic material is uniform with height and that the distributions of toxic material along the x- and y-layer coordinates are Gaussian.

4.2.1 Dosage Equation for Model 1

The dosage equation for Model 1 in the K^{th} layer is

$$D_K\left\{x_K, y_K, z_K\right\} = \frac{Q_K}{\sqrt{2\pi}\,\bar{u}_K\,\sigma_{yK}}\left\{\exp\left(\frac{-y_K^{\,2}}{2\sigma_{yK}^{\,2}}\right)\right\} \tag{4-1}$$

In the above expression

Q_K = the source strength in units of mass per unit layer depth

The quantity $\bar{u}_K$ in Equation (4-1) is the mean cloud transport speed in meters per second in the K^{th} layer. In the surface layer (K = 1), the wind speed-height profile is defined according to the power-law expression

$$\bar{u}\left\{z_K,\ K=1\right\} = \bar{u}_R\left(\frac{z_K\,\{K=1\}}{z_R}\right)^p \tag{4-2}$$

where

$\bar{u}_R$ = mean wind speed measured at the reference height z_R

p = power-law exponent for the wind speed profile in the surface layer

$$= \log\left(\frac{\bar{u}_{TK}\{K=1\}}{\bar{u}_R}\right)\Big/\log\left(\frac{z_{TK}\{K=1\}}{z_R}\right)$$

$\bar{u}_{TK}\{K=1\}$ = mean wind speed at the top of the surface layer $z_{TK}\{K=1\}$

$z_K\{K=1\}$ = height in the surface layer

Thus, in the surface layer, the mean cloud transport speed is defined by the expression

$$\bar{u}_K\{K=1\} = \frac{\bar{u}_R}{\left(z_{TK}\{K=1\} - z_R\right) z_R^{\,p}} \int_{z_R}^{z_{TK}} \left(z_K\{K=1\}\right)^p dz$$

$$= \frac{\bar{u}_R\left[\left(z_{TK}\{K=1\}\right)^{1+p} - \left(z_R\right)^{1+p}\right]}{\left(z_{TK}\{K=1\} - z_R\right)\left(z_R\right)^p\left(1+p\right)}$$

In layers above the surface layer ($K > 1$), the wind speed-height profile is assumed linear and defined by the expression

$$\bar{u}\{z_K, K>1\} = \bar{u}_{BK} + \left(\frac{\bar{u}_{TK} - \bar{u}_{BK}}{z_{TK} - z_{BK}}\right)\left(z_K - z_{BK}\right) \quad (4-3)$$

where

$\bar{u}_{TK}$ = mean wind speed at the top of the layer z_{TK}

$\bar{u}_{BK}$ = mean wind speed at the base of the layer z_{BK}

In the K^{th} layer ($K > 1$), the mean cloud transport speed is given by the expression

$$\bar{u}_K\{K>1\} = \left(\bar{u}_{TK} + \bar{u}_{BK}\right)/2$$

The standard deviation of the crosswind dosage distribution σ_{yK} is defined by the expression

$$\sigma_{yK} = \left\{\left[\sigma'_{AK}\{\tau_K\}\, x_{ryK}\left(\frac{x_K + x_{yK} - x_{ryK}(1-\alpha_K)}{\alpha_K\, x_{ryK}}\right)^{\alpha_K}\right]^2 + \left[\frac{\Delta\theta'_K\, x_K}{4.3}\right]^2\right\}^{1/2} \quad (4-4)$$

where

$\sigma'_{AK}\{\tau_K\}$ = mean layer standard deviation of the wind azimuth angle in radians for the cloud stabilization time τ_K

In the surface layer ($K = 1$),

$$\sigma'_{AK}\{\tau_K, K=1\} = \frac{\sigma'_{AR}\{\tau_K\}\left[\left(z_{TK}\{K=1\}\right)^{m+1} - \left(z_R\right)^{m+1}\right]}{(m+1)\left(z_{TK}\{K=1\} - z_R\right)\left(z_R\right)^m} \tag{4-5}$$

where

$\sigma'_{AR}\{\tau_K\}$ = standard deviation of the wind azimuth angle in radians at height z_R and for the cloud stabilization time τ_K

$$= \sigma_{AR}\{\tau_{oK}\}\left(\frac{\tau_K}{\tau_{oK}}\right)^{1/5}\left(\frac{\pi}{180}\right)$$

$\sigma_{AR}\{\tau_{oK}\}$ = standard deviation of the wind azimuth angle in degrees at height z_R and for the reference time period τ_{oK}

m = power-law exponent for the vertical profile of the standard deviation of the wind azimuth angle in the surface layer

$$= \log\left(\frac{\sigma'_{ATK}\{\tau_K, K=1\}}{\sigma'_{AR}\{\tau_K\}}\right) \Big/ \log\left(\frac{z_{TK}\{K=1\}}{z_R}\right)$$

$$\sigma'_{ATK}\{\tau_K, K=1\} = \sigma_{ATK}\{\tau_{oK}, K=1\}\left(\frac{\tau_K}{\tau_{oK}}\right)^{1/5}\left(\frac{\pi}{180}\right)$$

$\sigma_{ATK}\{\tau_{oK}, K=1\}$ = standard deviation of the wind azimuth angle in degrees at the top of the surface layer z_{TK} for the reference time period τ_{oK}

For layers above the surface ($K > 1$),

$$\sigma'_{ATK}\{\tau_K, K>1\} = \left(\sigma'_{ATK}\{\tau_K\} + \sigma'_{ABK}\{\tau_K\}\right) \Big/ 2 \tag{4-6}$$

where

$$\sigma'_{ATK}\{\tau_K\} = \sigma_{ATK}\{\tau_{oK}\} \left(\frac{\tau_K}{\tau_{oK}}\right)^{1/5} \left(\frac{\pi}{180}\right)$$

$\sigma_{ATK}\{\tau_{oK}\}$ = standard deviation of the wind azimuth angle in degrees at the top of the layer for the reference time period τ_{oK}

$$\sigma'_{ABK}\{\tau_K\} = \sigma_{ABK}\{\tau_{oK}\} \left(\frac{\tau_K}{\tau_{oK}}\right)^{1/5} \left(\frac{\pi}{180}\right)$$

$\sigma_{ABK}\{\tau_{oK}\}$ = standard deviation of the wind azimuth angle in degrees at the base of the layer for the reference time period τ_{oK}

x_K = downwind distance from the source

y_K = crosswind distance from the axis of the cloud

x_{yK} = crosswind virtual distance

$$= \frac{\sigma_{yo}\{K\}}{\sigma'_{AK}\{\tau_K\}} - x_{RyK}$$

when $\sigma_{yo}\{K\} \leq \sigma'_{AK}\{\tau_K\}\, x_{ryK}$

$$= \alpha_K\, x_{ryK} \left(\frac{\sigma_{yo}\{K\}}{\sigma'_{AK}\{\tau_K\}\, x_{ryK}}\right)^{1/\alpha_K} - x_{RyK} + x_{ryK}(1-\alpha_K)$$

when $\sigma_{yo}\{K\} \geq \sigma'_{AK}\{\tau_K\}\, x_{ryK}$

$\sigma_{yo}\{K\}$ = standard deviation of the lateral source dimension in the layer at downwind distance x_{RyK}

x_{RyK} = distance from the source at which $\sigma_{yo}\{K\}$ is measured in the K^{th} layer

x_{ryK} = distance over which rectilinear crosswind expansion occurs downwind from an ideal point source in the K^{th} layer

α_K = lateral diffusion coefficient in the layer

$\Delta\theta'_K$ = vertical wind direction shear in the layer

$$= \left(\theta_{TK} - \theta_{BK}\right)\left(\frac{\pi}{180}\right)$$

θ_{TK} = mean wind direction in degrees at the top of the layer

θ_{BK} = mean wind direction in degrees at the base of the layer

4.2.2 Concentration Equation for Model 1

The maximum concentration for Model 1 in the K^{th} layer is given by the expression

$$\chi_K\{x_K, y_K, z_K\} = \frac{D_K\, \bar{u}_K}{\sqrt{2\pi}\, \sigma_{xK}} \tag{4-7}$$

where

σ_{xK} = standard deviation of the alongwind concentration distribution in the layer

$$= \left[\left(\frac{L\{x_K\}}{4.3}\right)^2 + \sigma_{xo}^{\ 2}\{K\}\right]^{1/2} \tag{4-8}$$

$L\{x_K\}$ = alongwind cloud length for a point source in the layer at the distance x_K from the source

$$= \begin{cases} \dfrac{0.28\left(\Delta\bar{u}_K\right)\left(x_K\right)}{\bar{u}_K} & ; \quad \Delta\bar{u}_K \geq 0 \\[2ex] 0 & ; \quad \Delta\bar{u}_K \leq 0 \end{cases} \tag{4-9}$$

$\Delta \bar{u}_K$ = vertical wind speed shear in the layer

$\Delta \bar{u}_K\{K=1\} = \bar{u}_{TK}\{K=1\} - \bar{u}_R$

$\Delta \bar{u}_K\{K>1\} = \bar{u}_{TK} - \bar{u}_{BK}$

$\sigma_{xo}\{K\}$ = standard deviation of the alongwind source dimension in the layer at the point of cloud stabilization

The above equation for $L\{x_K\}$ is based on the theoretical and empirical results reported by Tyldesley and Wallington (1965) who analyzed ground-level concentration measurements made at distances of 5 to 120 kilometers downwind from instantaneous line-source releases.

The maximum centerline concentration for Model 1 in the K^{th} layer is given by the expression

$$\chi_{CK}\{x_K, y_K=0, z_K\} = \chi_K / \{\text{LATERAL TERM}\} \tag{4-10}$$

The average alongwind concentration is defined as

$$\bar{\chi}_K = D_K / t_{pK} \tag{4-11}$$

where

t_{pK} = cloud passage time in seconds in the K^{th} layer

$\cong 4.3\ \sigma_{xK} / \bar{u}_K$

The time mean alongwind concentration in the K^{th} layer is defined by the expression

$$\chi_K\{x_K, y_K, z_K; T_A\} = \frac{D_K}{T_A}\left\{\operatorname{erf}\left(\frac{\bar{u}_K T_A}{2\sqrt{2}\ \sigma_{xK}}\right)\right\} \tag{4-12}$$

where

T_A = time in seconds over which concentration is to be averaged

The time mean alongwind concentration is equivalent to the average alongwind concentration when t_{pK} equals T_A.

4.3 MODEL 2

Layer Model 2 refers to the same source configuration as Model 1 in which the source extends vertically through the entire depth of the layer and the distribution of toxic material is uniform with height. In Model 2, however, it is assumed that no turbulent mixing is occurring. Consequently, there is no dilution of the cloud due to turbulent expansion. The dosage and concentration equations for Model 2 are given by Equations (4-1) and (4-7), respectively, with the following substitutions:

$$\sigma_{yK} = \sigma_{yo}\{K\} \tag{4-13}$$

$$\sigma_{xK} = \sigma_{xo}\{K\} \tag{4-14}$$

4.4 MODEL 3

This layer model differs from Models 1 and 2 in that the vertical extent of the source is less than the depth of the layer. The model equation thus contains vertical expansion terms.

4.4.1 Dosage Equation for Model 3

The dosage equation for Model 3 in the K^{th} layer is given by the expression

$$D_K\{x_K, y_K, z_{BK} < z_K < z_{TK}\} = \frac{Q_K}{2\pi\, \sigma_{yK}\, \sigma_{zK}\, \bar{u}_K} \left\{ \exp\left[\frac{-y_K^2}{2\sigma_{yK}^2}\right] \right\}$$

$$\left\{ \exp\left[\frac{-(H_K - z_K)^2}{2\sigma_{zK}^2}\right] + \exp\left[\frac{-(H_K - 2z_{BK} + z_K)^2}{2\sigma_{zK}^2}\right] \right.$$

$$+ \sum_{i=1}^{\infty} \left\{ \exp\left[\frac{-\left(2i\left(z_{TK} - z_{BK}\right) - \left(H_K - 2z_{BK} + z_K\right)\right)^2}{2\sigma_{zK}^2}\right] \right. \tag{4-15}$$

$$\exp\left[\frac{-\left(2i\left(z_{TK} - z_{BK}\right) + \left(H_K - z_K\right)\right)^2}{2\sigma_{zK}^2}\right] + \exp\left[\frac{-\left(2i\left(z_{TK} - z_{BK}\right) - \left(H_K - z_K\right)\right)^2}{2\sigma_{zK}^2}\right]$$

$$\left. \left. + \exp\left[\frac{-\left(2i\left(z_{TK} - z_{BK}\right) + \left(H_K - 2z_{BK} + z_K\right)\right)^2}{2\sigma_{zK}^2}\right] \right\} \right\}$$

where

Q_K = source strength or total mass of material in the layer

H_K = effective source height or height of the centroid of the stabilized cloud

σ_{zK} = standard deviation of the vertical dosage distribution in the layer

The remaining terms are the same as those in Equation (4-1) for Model 1.

The standard deviation of the vertical dosage distribution is defined by the expression

$$\sigma_{zK} = \sigma'_{EK}\, x_{rzK} \left(\frac{x_K + x_{zK} - x_{rzK}(1-\beta_K)}{\beta_K\, x_{rzK}} \right)^{\beta_K} \tag{4-16}$$

where

σ'_{EK} = mean standard deviation of the wind elevation angle in radians for the layer

x_{zK} = vertical virtual distance in the layer

β_K = vertical diffusion coefficient in the layer

x_{rzK} = distance over which rectilinear vertical expansion occurs downwind from an ideal point source in the K^{th} layer

In the surface layer ($K = 1$),

$$\sigma_{EK}\{K=1\} = \frac{\sigma_{ER}\left[\left(z_{TK}\{K=1\}\right)^{q+1} - \left(z_R\right)^{q+1}\right]}{\left(q+1\right)\left(z_{TK}\{K=1\} - z_R\right)\left(z_R\right)^q} \left(\frac{\pi}{180}\right) \tag{4-17}$$

where

σ_{ER} = standard deviation of the wind elevation angle in degrees at the height z_R

q = power-law exponent for the vertical profile of the standard deviation of the wind elevation angle in the surface layer

$$= \log\left(\frac{\sigma_{ETK}\{K=1\}}{\sigma_{ER}}\right) \Big/ \log\left(\frac{z_{TK}\{K=1\}}{z_R}\right)$$

$\sigma_{ETK}\{K=1\}$ = standard deviation of the wind elevation angle in degrees at the top of the surface layer

Above the surface layer ($K > 1$),

$$\sigma'_{EK}\{K>1\} = \left(\sigma_{ETK} + \sigma_{EBK}\right)\left(\frac{\pi}{360}\right)$$

where

σ_{ETK} = standard deviation of the wind elevation angle in degrees at the top of the layer

σ_{EBK} = standard deviation of the wind elevation angle in degrees at the base of the layer

The vertical virtual distance x_{zK} is given by the expression

$$\left\{ \begin{array}{ll} \dfrac{\sigma_{zo}\{K\}}{\sigma'_{EK}} - x_{RzK} & ; \ \sigma_{zp}\{K\} \leq \sigma'_{EK}\, x_{rzK} \\ \\ \beta_K\, x_{rzK} \left(\dfrac{\sigma_{zo}\{K\}}{\sigma'_{EK}\, x_{rzK}} \right)^{1/\beta_K} - x_{RzK} + x_{rzK}(1-\beta_K) & ; \ \sigma_{zo}\{K\} \geq \sigma'_{EK}\, x_{rzK} \end{array} \right\}$$

where

$\sigma_{zo}\{K\}$ = standard deviation of the vertical dosage distribution at x_{RzK}

x_{RzK} = distance from the source at which $\sigma_{zo}\{K\}$ is measured in the K^{th} layer

4.4.2 Concentration Equation for Model 3

The concentration equation for Model 3 is the same as that for Model 1 which is given by Equation (4-7) in Section 4.2.2 with D_K from Equation (4-15). Equation (4-10) in Section 4.2.2 also gives the maximum centerline concentration for Model 3. Similarly, average and time mean alongwind concentrations for Model 3 are given by Equations (4-11) and (4-12) with D_K from Equation (4-15).

4.5 MODEL 4

Model 4, the layer-breakdown model, may be used to calculate concentration and dosage fields resulting from changes in the meteorological layer structure. Model 4 may also be used to determine concentration and dosage fields in the surface mixing layer downwind from a source in which the source strength varies with height in the layer. The application of Model 4 requires the following assumptions:

- The boundary between adjacent layers or sublayers is eliminated and the layers are replaced by a single layer L

- Turbulent mixing is occurring in Layer L

- The material in each of the layers or sublayers is initially uniformly distributed in the vertical

- Reflection occurs at the upper and lower boundaries of Layer L

The selection of Model 4 for layer breakdown calculations or to accommodate vertical source strength variations in the surface mixing layer is controlled in the computer program by selection of certain options (see Appendix B) available in the input configuration. If no special provision is made and Model 4 is specified for use, the program assumes that the function of the model is to accommodate to vertical source strength variations. For example, the surface mixing layer can be divided into several sublayers where the source strength, although assumed to be vertically uniform in the K^{th} sublayer, increases with height in subsequent layers (see example problems in Section 6). In this case, Model 4 calculates the contribution from each sublayer to the composite concentration and dosage fields in the surface mixing layer by permitting turbulent mixing across the initial sublayer boundaries.

If Model 4 is to be used to predict the concentration and dosage fields downwind from a change in meteorological structure, the program option ISKIP(2) must be properly set, the input parameter NBK must be initialized, and the meteorological parameters for the new L^{th} layer and the time t^* at which layer breakdown occurs must be specified (see Appendix B).

4.5.1 Dosage Equation for Model 4

The dosage equation for Model 4 for the contribution from the portion of the cloud in the K^{th} layer to the receptor position in the layer L is given by the expression

$$D_{LK} = \frac{Q_K}{2\sqrt{2\pi}\ \bar{u}_L\ \sigma_{yLK}} \left\{ \exp\left[- \left(\frac{y_L^{\ 2}}{2\ \sigma_{yLK}^{\ 2}} \right) \right] \right\}$$

$$\left\{ \sum_{i=0}^{\infty} \left[\mathrm{erf}\left(\frac{2i\left(z_{TL}-z_{BL}\right)-z_{BK}+z_L}{\sqrt{2}\ \ \sigma_{zLK}} \right) + \mathrm{erf}\left(\frac{2i\left(z_{TL}-z_{BL}\right)+z_{TK}-z_L}{\sqrt{2}\ \ \sigma_{zLK}} \right) \right. \right.$$

$$+ \mathrm{erf}\left(\frac{2i\left(z_{TL}-z_{BL}\right)+2z_{BL}-z_{BK}-z_L}{\sqrt{2}\ \ \sigma_{zLK}} \right) + \mathrm{erf}\left(\frac{2i\left(z_{TL}-z_{BL}\right)-2z_{BL}+z_{TK}+z_L}{\sqrt{2}\ \ \sigma_{zLK}} \right) \tag{4-18}$$

$$+ \sum_{i=1}^{\infty} \mathrm{erf}\left(\frac{-2i\left(z_{TL}-z_{BL}\right)-z_{BK}+z_L}{\sqrt{2}\ \ \sigma_{zLK}} \right) + \mathrm{erf}\left(\frac{-2i\left(z_{TL}-z_{BL}\right)+z_{TK}-z_L}{\sqrt{2}\ \ \sigma_{zLK}} \right)$$

$$\left. \left. + \mathrm{erf}\left(\frac{-2i\left(z_{TL}-z_{BL}\right)+2z_{BL}-z_{BK}-z_L}{\sqrt{2}\ \ \sigma_{zLK}} \right) + \mathrm{erf}\left(\frac{-2i\left(z_{TL}-z_{BL}\right)-2z_{BL}+z_{TK}+z_L}{\sqrt{2}\ \ \sigma_{zLK}} \right) \right] \right\}$$

The total contribution to a receptor position in Layer L is calculated by summing the contributions from all K layers. In the above expression

Q_K = source strength in units of mass per unit layer depth ($g\ m^{-1}$) for the source in the layer K

In Model 4, the quantity $\bar{u}_L$ is the mean cloud transport in the L^{th} layer. If the layer L is the surface mixing layer (L = 1), the wind speed-height profile is defined according to the expression

$$\bar{u}\{z_L, L=1\} = \bar{u}_{RL}\left(\frac{z_L\{L=1\}}{z_R}\right)^{p_L}$$

where

$\bar{u}_{RL}$ = mean wind speed at the reference height z_R in the new surface layer L

p_L = power-law exponent for the wind speed profile in the surface layer (L = 1)

$$= \log\left(\frac{\bar{u}_{TL}\{L=1\}}{\bar{u}_{RL}}\right) \Big/ \log\left(\frac{z_{TL}\{L=1\}}{z_R}\right)$$

$\bar{u}_{TL}\{L=1\}$ = mean wind speed at the top of the surface layer $z_{TL}\{L=1\}$

$z_L\{L=1\}$ = height in the surface layer

The mean cloud transport speed in the surface layer is given by

$$\bar{u}_L\{L=1\} = \frac{\bar{u}_{RL}\left[\left(z_{TL}\{L=1\}\right)^{1+p_L} - \left(z_R\right)^{1+p_L}\right]}{\left(z_{TL}\{L=1\} - z_R\right)\left(z_R\right)^{p_L}\left(1+p_L\right)} \qquad (4\text{-}19)$$

For layers above the surface layer (L > 1), the wind speed-height profile is assumed to be defined by the expression

$$\bar{u}\{z_{LK}, L>1\} = \bar{u}_{BL} + \left(\frac{\bar{u}_{TL} - \bar{u}_{BL}}{z_{TL} - z_{BL}}\right)\left(z_L - z_{BL}\right)$$

where

$\bar{u}_{TL}$ = mean wind speed at the top of the layer z_{TL}

$\bar{u}_{BL}$ = mean wind speed at the base of the layer z_{BL}

The mean cloud transport speed is thus,

$$\bar{u}_L\{L>1\} = \left(\bar{u}_{TL} + \bar{u}_{BL}\right)/2 \tag{4-20}$$

The crosswind distance from the axis of the cloud to a receptor y_L (defined positive to the right looking downwind) is given by the expression

$$y_L = \left(y_j - y_{SK}\right) \sin \theta'_L - \left(x_j - x_{SK}\right) \cos \theta'_L \tag{4-21}$$

where

x_j, y_j = position of the receptor with respect to the origin of the reference coordinate system with the y axis positive northward and the x axis positive eastward

x_{SK}, y_{SK} = coordinates of the cloud centroid in the K^{th} layer at time t^* with respect to the origin of the reference coordinate system

$x_{SK} = x_i - \bar{u}_K t^* \sin \theta'_K$

$y_{SK} = y_i - \bar{u}_K t^* \cos \theta'_K$

x_i, y_i = coordinates of the real source in the K^{th} layer with respect to the origin of the reference coordinate system

$\theta'_L = \left(\theta_{TL} + \theta_{BL}\right)\left(\frac{\pi}{360}\right)$

θ_{TL} = mean wind direction in degrees at the top of the layer z_{TL}

θ_{BL} = mean wind direction in degrees at the base of the layer z_{BL}

$\theta'_K = \left(\theta_{TK} + \theta_{BK}\right)\left(\frac{\pi}{360}\right)$

The standard deviation of the crosswind dosage distribution σ_{yLK} in the L^{th} layer is defined by the expression

$$\sigma_{yLK} = \left\{ \left[\sigma_{AL}\{\tau_L\} x_{ryL} \left(\frac{x_L + x^*_{vKL} - x_{rvL}(1-\alpha_L)}{\alpha_L x_{ryL}} \right)^{\alpha_L} \right]^2 + \left[\frac{\Delta\theta'_L x_L}{4.3} \right]^2 \right\}^{1/2} \tag{4-22}$$

where

$\sigma'_A\{\tau_L\}$ = mean layer standard deviation of the wind azimuth angle in radians for the effective cloud stabilization time τ_L

In the surface layer (L = 1),

$$\sigma'_{AL}\{\tau_L, L=1\} = \frac{\sigma'_{ARL}\{\tau_L\} \left[\left(z_{TL}\{L=1\}\right)^{m_L+1} - \left(z_R\right)^{m_L+1} \right]}{\left(m_L+1\right)\left(z_{TL}\{L=1\} - z_R\right)\left(z_R\right)^{m_L}} \tag{4-23}$$

where

$\sigma'_{ARL}\{\tau_L\}$ = standard deviation of the wind azimuth angle in radians at height z_R and for time τ_L

$$= \sigma_{ARL}\{\tau_{oL}\} \left(\frac{\tau_L}{\tau_{oL}} \right)^{1/5} \left(\frac{\pi}{180} \right)$$

$\sigma_{ARL}\{\tau_{oL}\}$ = standard deviation of the wind azimuth angle in degrees at height z_R and for the reference time period τ_{oL}

m_L = power-law exponent for the vertical profile of the standard deviation of the wind azimuth angle in the surface layer L = 1

$$m_L = \log\left(\frac{\sigma'_{ATL}\{\tau_L, L=1\}}{\sigma'_{ARL}\{\tau_L\}}\right) \Big/ \log\left(\frac{z_{TL}\{L=1\}}{z_R}\right)$$

$$\sigma'_{ATL}\{\tau_L, L=1\} = \sigma_{ATL}\{\tau_{oL}, L=1\} \left(\frac{\tau_L}{\tau_{oL}}\right)^{1/5} \left(\frac{\pi}{180}\right)$$

$\sigma_{ATL}\{\tau_{oL}, L=1\}$ = standard deviation of the wind azimuth angle in degrees at the top of the surface layer z_{TL} for the reference time period τ_{oL}

For layers above the surface layer (L > 1),

$$\sigma'_{AL}\{\tau_L, L>1\} = \left(\sigma'_{ATL}\{\tau_L\} + \sigma'_{ABL}\{\tau_L\}\right)\Big/2 \tag{4-24}$$

where

$$\sigma'_{ATL}\{\tau_L\} = \sigma_{ATL}\{\tau_{oL}\} \left(\frac{\tau_L}{\tau_{oL}}\right)^{1/5} \left(\frac{\pi}{180}\right)$$

$\sigma_{ATL}\{\tau_{oL}\}$ = standard deviation of the wind azimuth angle in degrees at the top of the layer for the reference time period τ_{oL}

$$\sigma'_{ABL}\{\tau_L\} = \sigma_{ABL}\{\tau_{oL}\} \left(\frac{\tau_L}{\tau_{oL}}\right)^{1/5} \left(\frac{\pi}{180}\right)$$

$\sigma_{ABL}\{\tau_{oL}\}$ = standard deviation of the wind azimuth angle in degrees at the base of the layer for the reference time τ_{oL}

The wind direction shear in radians in the layer is given by the expression

$$\Delta\theta'_L = \left(\theta_{TL} - \theta_{BL}\right) \left(\frac{\pi}{180}\right)$$

The crosswind virtual distance in the L^{th} layer due to source (cloud) originating in the K^{th} layer is given by the expression

$$x^*_{yKL} = x_{ryL} \left(\frac{\sigma^*_{vKL}}{\sigma'_{AL}\{\tau_L\}\, x_{ryL}} \right)^{1/\alpha_L} + x_{ryL}(1-\alpha_L)$$

where

σ^*_{yKL} = crosswind source dimension in Layer L due to source (cloud) originating in the K^{th} layer

$$= \left\{ \left[\left(\sigma^*_{xK} \right)^2 \sin^2 \left(\theta'_K - \theta'_L \right) \right] + \left[\left(\sigma^*_{yK} \right)^2 \cos^2 \left(\theta'_K - \theta'_L \right) \right] \right\}^{1/2}$$

σ^*_{xK} = alongwind standard deviation of the dosage distribution in the K^{th} layer at time t^*

σ^*_{yK} = crosswind standard deviation of the dosage distribution in the K^{th} layer at time t^*

α_L = lateral diffusion coefficient in the layer

x_{ryL} = distance over which rectilinear crosswind expansion occurs downwind from an ideal point source in the L^{th} layer

The downwind distance from the point where the change in layer structure occurs for the source (cloud) in the K^{th} layer to the point where the dosage is to be calculated x_L is given by the expression

$$x_L = -\left(x_j - x_{SK} \right) \sin \theta'_L - \left(y_j - y_{SK} \right) \cos \theta'_L \qquad (4\text{-}25)$$

The standard deviation of the vertical dosage distribution σ_{zLK} in the L^{th} layer is defined by the expression

$$\sigma_{zLK} = \sigma'_{EL}\, x_{rzL} \left(\frac{x_L}{x_{rzL}} \right)^{\beta_L} \qquad (4\text{-}26)$$

where

σ'_{EL} = mean standard deviation of the wind elevation angle in radians for the layer

β_L = vertical diffusion coefficient in the layer

x_{rzL} = distance over which rectilinear vertical expansion occurs downwind of an ideal point source in the L^{th} layer

In the surface layer (L = 1),

$$\sigma'_{EL}\{L=1\} = \frac{\sigma_{ERL}\left[\left(z_{TL}\{L=1\}\right)^{q_L+1} - \left(z_R\right)^{q_L+1}\right]}{\left(q_L+1\right)\left(z_{TL}\{L=1\} - z_R\right)\left(z_R\right)^{q_L}} \left(\frac{\pi}{180}\right) \tag{4-27}$$

where

σ_{ERL} = standard deviation of the wind elevation angle in degrees at the reference height z_R

q_L = power-law exponent for the vertical profile of the standard deviation of the wind elevation angle in the surface layer

$$= \log\left(\frac{\sigma_{ETL}\{L=1\}}{\sigma_{ERL}}\right) \Big/ \log\left(\frac{z_{TL}\{L=1\}}{z_R}\right)$$

$\sigma_{ETL}\{L=1\}$ = standard deviation of the wind elevation angle in degrees at the top of the layer z_{TL}

Above the surface layer (L > 1),

$$\sigma'_{EL}\{L>1\} = \left(\sigma_{ETL} + \sigma_{EBL}\right)\left(\frac{\pi}{360}\right) \tag{4-28}$$

where

σ_{ETL} = standard deviation of the wind elevation angle in degrees at the top of the layer z_{TL}

σ_{EBL} = standard deviation of the wind elevation angle in degrees at the base of the layer z_{BL}

4.5.2 Concentration Equation for Model 4

The maximum concentration equation for Model 4 is given by the expression

$$\chi_{LK}\{x_L, y_L, z_L\} = \frac{D_{LK}\ \bar{u}_L}{\sqrt{2\pi}\ \sigma_{xLK}} \tag{4-29}$$

where

σ_{xLK} = standard deviation of the cloud alongwind concentration distribution in the layer

$$= \left[\left(\frac{L\{x_{LK}\}}{4.3}\right)^2 + \left(\sigma^*_{xKL}\right)^2\right]^{1/2}$$

$L\{x_{LK}\}$ = alongwind cloud length of a point source at distance x_L

$$= \begin{Bmatrix} \dfrac{0.28\ \Delta\bar{u}_L\ x_L}{\bar{u}_L} & ; & \bar{u}_L \geq 0 \\ 0 & ; & \bar{u}_L \leq 0 \end{Bmatrix} \tag{4-30}$$

$\Delta\bar{u}_L$ = vertical wind speed shear in the layer

$\Delta\bar{u}_L\{L=1\} = \bar{u}_{TL}\{L=1\} - \bar{u}_{RL}$

$\Delta\bar{u}_L\{L>1\} = \bar{u}_{TL} - \bar{u}_{BL}$

σ^*_{xKL} = alongwind source dimension in Layer L due to source (cloud) originating in the K^{th} layer

$$= \left\{\left[\left(\sigma^*_{xK}\right)^2 \cos^2\left(\theta'_K - \theta'_L\right)\right] + \left[\left(\sigma^*_{yK}\right)^2 \sin^2\left(\theta'_K - \theta'_L\right)\right]\right\}^{1/2}$$

The maximum centerline concentration for Model 4 in the L^{th} layer is given by the expression

$$\chi_{CLK}\{x_{LK}, y_{LK} = 0, z_{LK}\} = \chi_{LK} / \{\text{LATERAL TERM}\}$$

$$\chi_{LK}\left\{\exp\left[-\left(\frac{y_L^2}{2\sigma_{yLK}^2}\right)\right]\right\}^{-1} \tag{4-31}$$

The average alongwind concentration at the cloud centerline is defined as

$$\bar{\chi}_{LK} = D_{LK} / t_{pL} \tag{4-32}$$

where

t_{pL} = cloud passage time in seconds in the L^{th} layer

$= 4.3\,\sigma_{xLK} / \bar{u}_L$

The time mean alongwind concentration in the L^{th} layer is defined by the expression

$$\bar{\chi}_K\{x_{LK}, y_{LK}, z_{LK}; T_A\} = \frac{D_{LK}}{T_A}\left\{\operatorname{erf}\left(\frac{\bar{u}_L\, T_A}{2\sqrt{2}\,\sigma_{xLK}}\right)\right\} \tag{4-33}$$

4.6 MODEL 5

This model is used to calculate the amount of material deposited on the surface by precipitation scavenging in the K^{th} layer. The assumptions made in deriving the model are stated in Section 2.4. The ground-level deposition WD_K due to precipitation scavenging, for the case in which the vertical distribution of toxic material in the layer is uniform with height is given by the expression .

$$WD_K\{x_K, y_K, z=0\} = \frac{\Lambda\, Q_K(z_{TK} - z_{BK})}{\sqrt{2\pi}\;\sigma_{yK}\;\bar{u}_K} \left\{\exp\left[-\frac{1}{2}\left(\frac{y_K}{\sigma_{yK}}\right)^2\right]\right\}$$

$$\left\{\exp\left[-\Lambda\left(\frac{x_K}{\bar{u}_K} - t_1\right)\right]\right\} \quad (4\text{-}34)$$

where

Q_K = source strength in units of mass per unit layer depth ($g\ m^{-1}$) for the source in Layer K

t_1 = time precipitation begins

Λ = percent of material removed per unit time

For the case in which the vertical extent of the source is less than the depth of the layer (Model 3), the term $z_{TK} - z_{BK}$ in Equation (4-34) is set equal to unity.

When changes in layer structure occur at time t*, the contribution to ground deposition WD_{LK} due to precipitation scavenging in the K^{th} layer is given by the expression

$$WD_{LK}\left\{x_L, y_L, z=0\right\} = \frac{\Lambda\, Q_K\left(z_{TK} - z_{BK}\right)}{\sqrt{2\pi}\;\sigma_{yLK}\;\bar{u}_L} \left\{\exp\left[-\frac{1}{2}\left(\frac{y_L}{\sigma_{yLK}}\right)^2\right]\right\}$$

$$\left\{\exp\left[-\Lambda\left(\frac{x_L}{\bar{u}_L} + t^* - t_1\right)\right]\right\} \quad (4\text{-}35)$$

Maximum ground-level deposition at a point $(x_L, y_L, z=0)$, assuming no previous cloud depletion due to scavenging, can be obtained by setting the second

exponential term in Equation (4-35) to unity. Total ground deposition is obtained by summing the contributions from all layers through which precipitation is falling at points on the reference grid coordinate system. The height of the top of the uppermost layer through which precipitation is falling z_{lim} must be supplied as an input to the computer program.

The dosage or concentration at a point in space, assuming precipitation scavenging occurs, is obtained by multiplying the appropriate dosage or concentration equation by the exponential term in Equation (4-34) or (4-35) containing the coefficient Λ.

4.7 MODEL 6

This model is used to calculate the ground deposition due to gravitational settling. The basic source configuration is an area source of finite lateral extent and unit vertical extent. Other source configurations are treated by summing the deposition at the ground resulting from a number of basic sources arranged to simulate the desired configuration. The model is essentially a tilted plume model in which the effects of wind shear are taken into account. The axis of a particle or droplet cloud of a given settling velocity intersects the ground plane at a distance from the source and at an angle from the mean surface wind direction that are proportional to the total angular wind shear and the residence time of the settling material in the layers between the source and the ground surface. In any layer, the inclination of the cloud axis from the horizontal is given by $\tan^{-1} V_s/\bar{u}$, where V_s is the particle or droplet settling velocity and $\bar{u}$ is the mean transport wind speed in the layer. In all cases, material released in the K^{th} layer and dispersed upwards by turbulence is assumed to be reflected downwards at the interface of the K^{th} and $(K + 1)^{th}$ layers. The basic model is used to calculate the ground-level deposition pattern for a single value of the settling velocity. The total deposition

pattern is obtained by summing the results for all settling velocities representative of the particle or droplet-size distribution of the released material on a reference coordinate grid system.

In the computer program, provision is made for calculating deposition from a source which fills the layer in the vertical and for a source in which the vertical extent is less than the depth of the layer. These models are described below.

4.7.1 Gravitational Deposition Model for a Source that Extends Vertically Through the Entire Layer

Ground-level deposition by gravitational settling for a source that extends vertically through the entire layer and in which the material is uniformly distributed in the vertical is calculated by summing contributions from a number of elementary sources in the K^{th} layer. Deposition at the surface for a single elementary source at height H_{nK} in the layer is given by the expression

$$DEP_{nK} = \frac{f_i\, Q_K\, T_K}{2\pi\, \sigma_{ynK}\, \xi_K} \left\{ M_{nK} + N_{nK} \right\} \left\{ \exp\left[-\frac{1}{2}\left(\frac{y_s}{\sigma_{ynK}} \right)^2 \right] \right\}$$

where

f_i = fraction of particles or droplets with settling velocity V_s

Q_K = source emission rate in layer K (g sec^{-1})

T_K = source emission time in layer K

ξ_K = number of elementary sources in layer K for simulating a uniform vertical distribution

y_s = lateral distance from the deposition axis of particles or droplets with settling velocity V_s

= $R_s \sin \phi_s$

R_s = radial distance in the horizontal plane from the source to a receptor

ϕ_s = angle between the axis of the ground-level deposition pattern and the radial connecting source and receptor for settling velocity V_s

The terms M_{nK} and N_{nK} are vertical terms that include provision for reflection from the boundary between the K^{th} and $(K + 1)^{th}$ layers. These terms are defined by the expressions

$$M_{nK} = \left\{ \frac{\bar{\beta}_K H_{nK} + \left((1-\beta_K) V_s x_s / \bar{u}_{nK}\right)}{\sigma_{EnK}(x_s)^{1+\bar{\beta}_K}} \right\} \left\{ \exp\left[-\frac{1}{2} \left(\frac{H_{nK} - (V_s x_s / \bar{u}_{nK})}{\sigma_{EnK}(x_s)^{1+\bar{\beta}_K}} \right)^2 \right] \right\} \tag{4-37}$$

$$N_{nK} = \left\{ \frac{\bar{\beta}_K (2 z_{TK} - H_{nK}) - \left((1-\bar{\beta}_K) V_s x_s / \bar{u}_{nK}\right)}{\sigma_{EnK}(x_s)^{1+\bar{\beta}_K}} \right\}$$
$$\left\{ \exp\left[-\frac{1}{2} \left(\frac{2 z_{TK} - H_{nK} + (V_s x_s / \bar{u}_{nK})}{\sigma_{EnK}(x_s)^{\bar{\beta}_K}} \right)^2 \right] \right\} \tag{4-38}$$

where

x_s = $R_s \cos \phi_s$

$\bar{u}_{nK}$ = mean wind transport speed in the layer between H_{nK} and the ground

$$= \frac{\left(X_{nK}^{\ 2} + Y_{nK}^{\ 2}\right)^{1/2}}{H_{nK}} V_s$$

$$X_{nK} = \frac{\bar{u}_{HK}}{V_s b_K} \left\{ \sin\left[b_K (H_{nK} - z_{BK}) + S\theta'_{K-1} \right] - \sin\left(S\theta'_{K-1}\right) \right\}$$
$$+ \sum_{i=1}^{K-1} \left\{ \frac{\bar{u}_i}{V_s b_i} \left[\sin\left(S\theta'_i\right) - \sin\left(S\theta'_{i-1}\right) \right] \right\}$$

$$Y_{nK} = \frac{\bar{u}_{HK}}{V_s b_K} \left\{ \cos\left[b_K \left(H_{nK} - z_{BL} \right) + S\theta'_{K-1} \right] - \cos\left(S\theta'_{K-1} \right) \right\}$$

$$+ \sum_{i=1}^{K-1} \left\{ \frac{-\bar{u}_i}{V_s b_i} \left[\cos\left(S\theta'_i \right) - \cos\left(S\theta'_{i-1} \right) \right] \right\}$$

$$S\theta'_{K-1} = \sum_{i=1}^{K-1} \Delta\theta'_i$$

$$S\theta'_K = \sum_{i=1}^{K} \Delta\theta'_i$$

$$b_K = \frac{S\theta'_K - S\theta'_{K-1}}{z_{TK} - z_{BK}}$$

The quantity $\bar{u}_{HK}$ is the mean layer wind speed between the height H_{nK} and the base of the K^{th} layer. The following expressions define the mean layer wind speeds in the surface layer ($K = 1$) and the layers above the surface layer ($K > 1$):

$$\bar{u}_{HK}\{K=1\} = \frac{\bar{u}_R \left[\left(H_{nK}\{K=1\} \right)^{1+p} - \left(z_R \right)^{1+p} \right]}{(1+p)\left(H_{nK}\{K=1\} - z_R \right)\left(z_R \right)^p} \qquad (4\text{-}39)$$

$$\bar{u}_{HK}\{K>1\} = \left[\left(\frac{\bar{u}_{TK} - \bar{u}_{BK}}{z_{TK} - z_{BK}} \right) \left(\frac{H_{nK} - z_{BK}}{2} \right) \right] + \left[\frac{\bar{u}_{BK}}{2} \right] \qquad (4\text{-}40)$$

The mean standard deviation of the wind elevation angle in radians in the layer between H_{nK} and the base of the K^{th} layer is given by the expressions

$$\sigma'_{EnK}\{K=1\} = \frac{\sigma_{ER}\left[\left(H_{nK}\{K=1\}\right)^{1+q} - \left(z_R\right)^{1+p}\right]}{(1+q)\left(H_{nK}\{K=1\} - z_R\right)\left(z_R\right)^q} \left(\frac{\pi}{180}\right) \tag{4-41}$$

$$\sigma'_{EnK}\{K>1\} = \frac{1}{H_{nK}}\left\{\left[\sigma'_{EnK}\{K=1\}\right] + \left[\sum_{i=2}^{K-1} \sigma'_{Ei}\left(z_{Ti} - z_{Bi}\right)\right]\right.$$
$$\left. + \frac{\pi\left(H_{nK}-z_{BK}\right)}{360}\left[\left(\frac{\sigma_{ETK}-\sigma_{EBK}}{z_{TK}-z_{BK}}\right)\left(H_{nK} - z_{BK}\right) + \sigma_{EBK}\right]\right\} \tag{4-42}$$

The vertical diffusion coefficient in the layer between H_{nK} and the base of the K^{th} layer is given by the terms

$$\bar{\beta}_K\{K=1\} = \beta_K \tag{4-43}$$

$$\bar{\beta}_K\{K>1\} = \frac{1}{H_{nK}}\left\{\left[\sum_{i=1}^{K-1} \beta_i\left(z_{Ti} - z_{Bi}\right)\right] + \left[\beta_K\left(H_{nK} - z_{BK}\right)\right]\right\} \tag{4-44}$$

The standard deviation of the crosswind distribution of material downwind from the source σ_{ynK} is given by the expression

$$\sigma_{ynK} = \left\{\left[\sigma'_{AnK}\left(x_s + x_{yK}\right)^{\bar{\alpha}_K}\right]^2 + \left[\Delta Y_K\right]^2\right\}^{1/2} \tag{4-45}$$

where

σ'_{AnK} = mean standard deviation of the wind azimuth angle in radians in the layer between H_{nK} and the ground

$$
\begin{cases}
\sigma'_{AnK}\{K=1\} = \dfrac{\sigma_{AR}\left[\left(H_{nK}\{K=1\}\right)^{1+m} - \left(z_R\right)^{1+m}\right]}{(1+m)\left(H_{nK}\{K=1\} - z_R\right)\left(z_R\right)^m} \left(\dfrac{\pi}{180}\right) \\[2ex]
\sigma'_{AnK}\{K>1\} = \dfrac{1}{H_{nK}} \left\{ \left[\sigma'_{AnK}\{K=1\}\right] + \left[\displaystyle\sum_{i=2}^{K-1} \sigma'_{Ai}\left(z_{Ti} - z_{Bi}\right)\right] \right. \\[2ex]
\qquad \left. + \dfrac{\pi\left(H_{nK} - z_{BK}\right)}{360} \left[\left(\dfrac{\sigma_{ATK} - \sigma_{BTK}}{z_{TK} - z_{BK}}\right)\left(H_{nK} - z_{BK}\right) + \sigma_{ABK}\right]\right\}
\end{cases} \tag{4-46}
$$

x_{yK} = lateral virtual distance in the layer

$$
= \left(\frac{\sigma_{yo}\{K\}}{\sigma_{AnK}}\right)^{1/\bar{\alpha}_K}
$$

$$
\Delta Y_K = \frac{\sigma'_{EnK}\left(x_s\right)^{\beta_K} Y_{nK}}{H_{nK}}
$$

The mean lateral diffusion coefficient in the layer between H_{nK} and the surface is given by the terms

$$
\begin{cases}
\bar{\alpha}_K\{K=1\} = \alpha_K \\[2ex]
\bar{\alpha}_K\{K>1\} = \dfrac{1}{H_{nK}} \left\{ \left[\displaystyle\sum_{i=1}^{K-1} \alpha_i \left(z_{Ti} - z_{Bi}\right)\right] + \left[\alpha_K\left(H_{nK} - z_{BK}\right)\right] \right\}
\end{cases} \tag{4-47}
$$

The number of elementary sources ξ_K required to simulate a uniformly distributed source in the vertical is given by the expression

$$
\xi_K = \left(z_{TK} - z_{BK}\right) / \Delta h_K \tag{4-48}
$$

where

Δh_K = vertical separation of elementary sources in the K^{th} layer

$$= R\sigma'_{EH}\left(X_{HK}^{\;2} + Y_{HK}^{\;2}\right)^{1/2}\left(1 + \frac{V_s}{\bar{u}_{HK}}\right)^{1/2}$$

R = a constant value depending on the accuracy desired in simulating a vertical line source configuration. A value of R = 0.45 yields deposition estimates that are within 10 percent of the true value

$$\sigma'_{EH} = \sigma'_{EnK} \text{ with } H_{nK} = \frac{1}{3}\left(z_{TK} - z_{BK}\right) + z_{BK}$$

$$X_{HK} = X_{nK} \text{ with } H_{nK} = \frac{1}{3}\left(z_{TK} - z_{BK}\right) + z_{BK}$$

$$Y_{HK} = Y_{nK} \text{ with } H_{nK} = \frac{1}{3}\left(z_{TK} - z_{BK}\right) + z_{BK}$$

$$\bar{u}_{HK} = \bar{u}_{nK} \text{ with } H_{nK} = \frac{1}{3}\left(z_{TK} - z_{BK}\right) + z_{BK}$$

The computer program for calculating gravitational deposition automatically distributes ξ_K sources in the K^{th} layer with uniform vertical spacing. The height H_{nK} in the above equations is the height above the ground of each elementary source.

The angle between the axis of the ground-level deposition pattern and the radial connecting source and receptor for settling velocity V_s is defined by the expression

$$\phi_s = \left|\theta_1 - 180 + \Phi_s - \theta_R\right| \quad \left(0 < \theta_1 < 180\right)$$
$$\phi_s = \left|\theta_1 + 180 + \Phi_s - \theta_R\right| \quad \left(180 < \theta_1 < 360\right) \tag{4-49}$$

where

θ_1 = mean wind direction at the reference height z_R

θ_R = angle between north and a line connecting source and receptor

$$\Phi_s = \tan^{-1}\left(\frac{Y_{nK}}{X_{nK}}\right)$$

4.7.2 Gravitational Deposition Model for a Volume Source in the K^{th} Layer

For a volume source at height H_{SK} in the K^{th} layer, the ground-level deposition from gravitational settling is given by the expression

$$DEP_{SK} = \frac{f_i \, Q_{SK}}{2\pi \, \sigma_{ySK}} \left\{ M_{SK} + N_{SK} \right\} \left\{ \exp\left[-\frac{1}{2} \left(\frac{y_{SK}}{\sigma_{ySK}} \right)^2 \right] \right\} \tag{4-50}$$

where the subscript SK indicates that the parameters refer to a single source in the K^{th} layer. The subset of equations which define the SK subscripted parameters is the same as the subset defining the terms in Equation (4-36), except the following substitution is made for the term x appearing in Equations (4-37) and (4-38):

$$x_s = R_{SK} \cos \phi_{SK} + x_{zSK} \tag{4-51}$$

where

x_{zSK} = the vertical virtual distance for the volume source

$$= \left(\frac{\sigma_{zo}\{SK\}}{\sigma'_{ESK}} \right)^{1/\beta_K}$$

σ'_{ESK} = mean standard deviation of the wind elevation angle in the layer between H_{SK} and the ground

$\sigma_{zo}\{SK\}$ = vertical source dimension of the volume source

In using Equation (4-50), deposition patterns from all values of V_{SK} representative of the particle or droplet size distribution of the volume source are summed on a reference coordinate system to obtain the total deposition pattern.

4.8 USE OF THE MULTILAYER CONSTRUCT FOR COLD SPILLS AND FUEL LEAKS IN THE SURFACE LAYER

The NASA/MSFC Multilayer Diffusion Model Program can be used, through adaptation of model inputs, to estimate concentration fields downwind from cold spills at the surface and fuel leaks near ground level. As mentioned in Section 2.5, the concentration model for continuous source emission is similar in form to the dosage model for instantaneous sources. In the computer program, Model 3 (described in Section 4) can be used as a concentration model for surface spills and leaks if proper adjustments are made in the values of the model input parameters. The adjustments include the requirement that the turbulence parameters σ_A and σ_E be specified at source height. Also, σ_A must be adjusted for emission times exceeding 10 minutes and the source strength Q_K must be specified in units of mass emitted per unit time.

As indicated above, for correct application of Model 3 to cold spills and fuel leaks, σ_A must be adjusted for source emission times. According to Hino (1968) and others, time-mean concentrations downwind from continuous sources are inversely proportional to the square root of the time τ for values of τ ranging from about 10 to 60 minutes. For $\tau \leq$ 10 minutes, a one-fifth power law is applicable (see Equation (2-12)). The computer program adjusts $\sigma_A\{\tau\}$ for source emission times less than 10 minutes, but has no provision for adjusting $\sigma_A\{\tau\}$ for source emission times exceeding 10 minutes. Thus, when source emission times exceed 10 minutes, the following substitute value of τ must be used in the program:

$$\tau \text{ (input value)} = \left(\tau_o\right)^{-3/2} \left(\tau\right)^{5/2} \tag{4-52}$$

where

τ_o = reference time period (between 10 and 60 minutes) over which $\sigma_A\{\tau_o\}$ is measured

τ = source emission time $\geq$ 10 minutes for cold spills and leaks

Appropriate values of $\sigma_A\{\tau_o\}$ and σ_E at the source height H can be obtained from the expression

$$\sigma_A\{\tau_o, H\} = \left\{ \begin{array}{ll} \sigma_{AR}\{\tau_{oK}\} \left(\frac{H}{z_R}\right)^m & ; \quad H \geq z_R \\ \\ \sigma_{AR}\{\tau_{oK}\} & ; \quad H < z_R \end{array} \right\} \tag{4-53}$$

$$\sigma_E\{H\} = \left\{ \begin{array}{ll} \sigma_{ER} \left(\frac{H}{z_R}\right)^q & ; \quad H \geq z_R \\ \\ \sigma_{ER} & ; \quad H < z_R \end{array} \right\} \tag{4-54}$$

where the power-law exponents m and q are defined in the text following Equations (4-5) and (4-17), respectively. These values must then be substituted for the inputs ordinarily used by the program from the following expressions

$$\sigma_{AR}\{\tau_{oK}\} \text{ (input value)} = \sigma_{ATK}\{\tau_{oK}\} \text{ (input value)} = \sigma_A\{\tau_o, H\} \tag{4-55}$$

$$\sigma_{ER} \text{ (input value)} = \sigma_{ETK} \text{ (input value)} = \sigma_E\{H\} \tag{4-56}$$

SECTION 5

DESCRIPTION OF THE NASA/MSFC MULTILAYER DIFFUSION MODEL COMPUTER PROGRAM

The NASA/MSFC Multilayer Diffusion Model Program combines the dosage, concentration and deposition models of Section 4 into a generalized computer program. This section describes the organization of the computer program.

5.1 ORGANIZATION OF THE COMPUTER PROGRAM

The computer program for the NASA/MSFC Multilayer Model is written in FORTRAN V and is designed for execution on a UNIVAC 1108 computer. The program consists of sixteen subroutines, including the main program and requires 29421_{10} words of core storage on the UNIVAC 1108 including systems and Fortran library programs.

Figure 5-1 shows in block diagram form the six diffusion models and the five major logic sections of the computer program. Logic section 1 provides for calculations of dosage, concentration, time mean alongwind concentration, time of passage, and average alongwind concentration patterns. Calculations are performed at selected points on a three-dimensional reference grid system where the horizontal plane is in polar coordinates and the vertical axis is provided by the atmospheric layer structure. The polar grid system in the horizontal plane fixes north at 0 degrees and east at 90 degrees with a maximum of 10,000 grid points. The vertical axis is limited to 20 layers and 100 possible calculation heights between the bottom and the top of the layer structure. As shown in Figure 5-1, logic section 1 uses Models 1 through 5 to calculate layer concentration and dosage patterns, with the option to include dosage and concentration with depletion due to precipitation scavenging or simple time dependent decay.

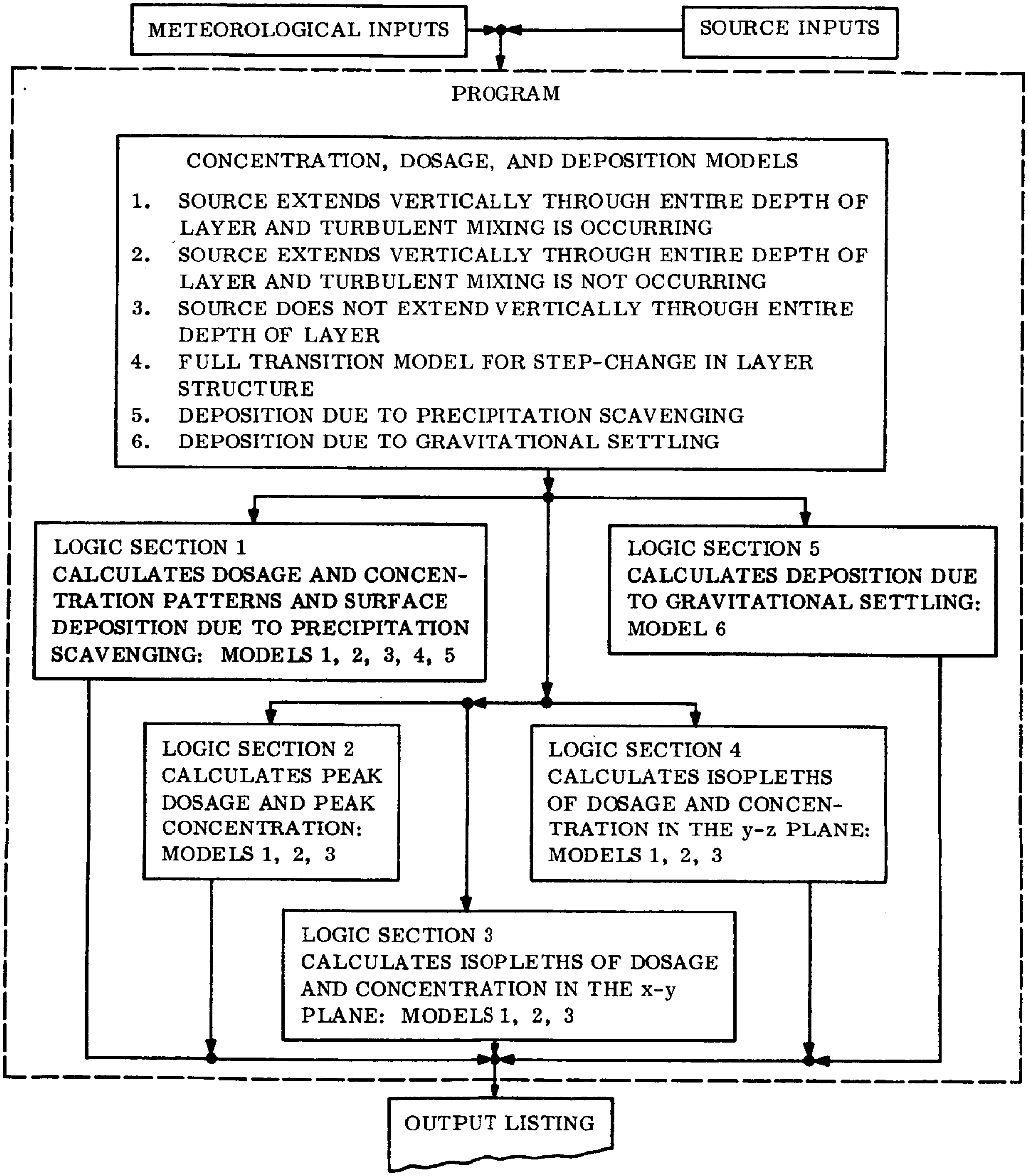

FIGURE 5-1. Block diagram of the computer program for the NASA/MSFC Multilayer Diffusion Model.

Logic sections 2 through 4 of the computer program provide for special calculations relative to the cloud alongwind axis in each layer. Section 2 produces maximum centerline concentration and centerline dosage on the alongwind cloud axis. Section 3 produces dosage and concentration isopleths in the horizontal plane about the alongwind cloud axis. Section 4 produces dosage and concentration isopleths in the vertical plane at selected distances, about the alongwind cloud axis. Sections 2 through 4 are applicable only to Models 1, 2 and 3 and provide the option of calculations with depletion due to precipitation scavenging or simple time-dependent decay.

Logic section 5 of the computer program calculates gravitational surface deposition patterns using Model 6. This section of the program uses the same grid system as explained for section 1. Provision is made in this section for an optional vehicle destruct in the uppermost layer.

A detailed explanation of the computer program is given in Appendix B and a complete listing of the program is given in Appendix C. Sample problems are described in detail in Section 6 with example program input data sheets shown in Appendix B and computer program output shown in Appendix D.

Assembly time for the computer program is approximately 26 seconds and the average run time is 0.01 seconds per calculation grid point.

SECTION 6
EXAMPLE CALCULATIONS

Example calculations have been made for both normal and abnormal launches of a rocket vehicle to illustrate the use of the computer program described in Section 5 in the estimation of downwind hazards. For this purpose, it has been assumed that the vehicle is a Titan III C and the launch and launch abort occur at Kennedy Space Center. Fuel properties and vehicle rise data for the Titan III C vehicle are described in Section 6.1 and the calculations for normal and abnormal launches are given in Sections 6.2 and 6.3, respectively.

6.1 FUEL PROPERTIES AND VEHICLE RISE DATA

Characteristic fuel properties used in the example calculations are given in Table 6-1. The fuel expenditure rate given in the table for a normal launch is an average rate for the first 40 seconds following ignition. The expenditure rate for an abnormal launch is based on the premise that the Titan III C vehicle is restrained on the pad because one solid-fueled engine of the Titan III C failed to ignite. In this case, one engine burns for a period of 112 seconds. The fuel heat content shown in the table for the solid-fueled engines does not include heat that may be generated by a recombination of chemical radicals as the exhaust cloud cools to ambient air temperature or the heat due to the release of kinetic energy. We have used this heat content because the cloud-rise values calculated using it are in good agreement with the limited measurements of cloud rise which are available.

The altitude-time curve of the Titan III C is also required to calculate the rise of the ground cloud of exhaust products during a normal launch. A logarithmic least-squares regression curve fitted to the data results in the approximate relationship

TABLE 6-1

FUEL PROPERTIES OF THE TITAN III C ZERO-STAGE ENGINES

Fuel Expenditure Rate ($g\ sec^{-1}$)	
Normal Launch	4.17×10^6
Abnormal Launch (On-Pad Abort)	1.74×10^6
Fuel Heat Content ($cal\ g^{-1}$)	
Normal and Abnormal Launch	691
Fuel Composition (Percent by Weight)	
HCl	20.8
Al_2O_3	30.7

$$t_R = 0.63463\ z^{0.4837} \qquad (6\text{-}1)$$

where

t_R = time after ignition in seconds

z = altitude above the pad in meters

Figure 6-1 shows a plot of the vehicle altitude versus time calculated from Equation (6-1).

6.2 NORMAL LAUNCH

The HCl concentration and dosage downwind from a normal launch of a Titan III C vehicle have been calculated to illustrate the use of Models 1, 3 and 4 described in Section 4. Washout deposition of HCl on the surface has been calculated using Model 5 and the gravitational deposition of Al_2O_3 has been calculated using Model 6.

6.2.1 Concentration and Dosage

<u>Meteorological Inputs</u>

Ground-level concentrations and dosages were calculated for the launch of a Titan vehicle during an afternoon sea-breeze regime, a meteorological regime typical of all seasons at Kennedy Space Center. Meteorological profiles of temperature, wind speed and wind direction obtained from rawinsonde data and from the NASA 150-Meter Ground Wind Tower at KSC are shown in Figure 6-2. Inspection of the vertical profile of temperature shows that the surface mixing layer extends to a height of 800 meters. The wind speed in the mixing layer increases from 6 meters per second at the surface to about 11 meters per second at the top of the layer. The wind direction veers from 150 degrees at the surface to 180 degrees

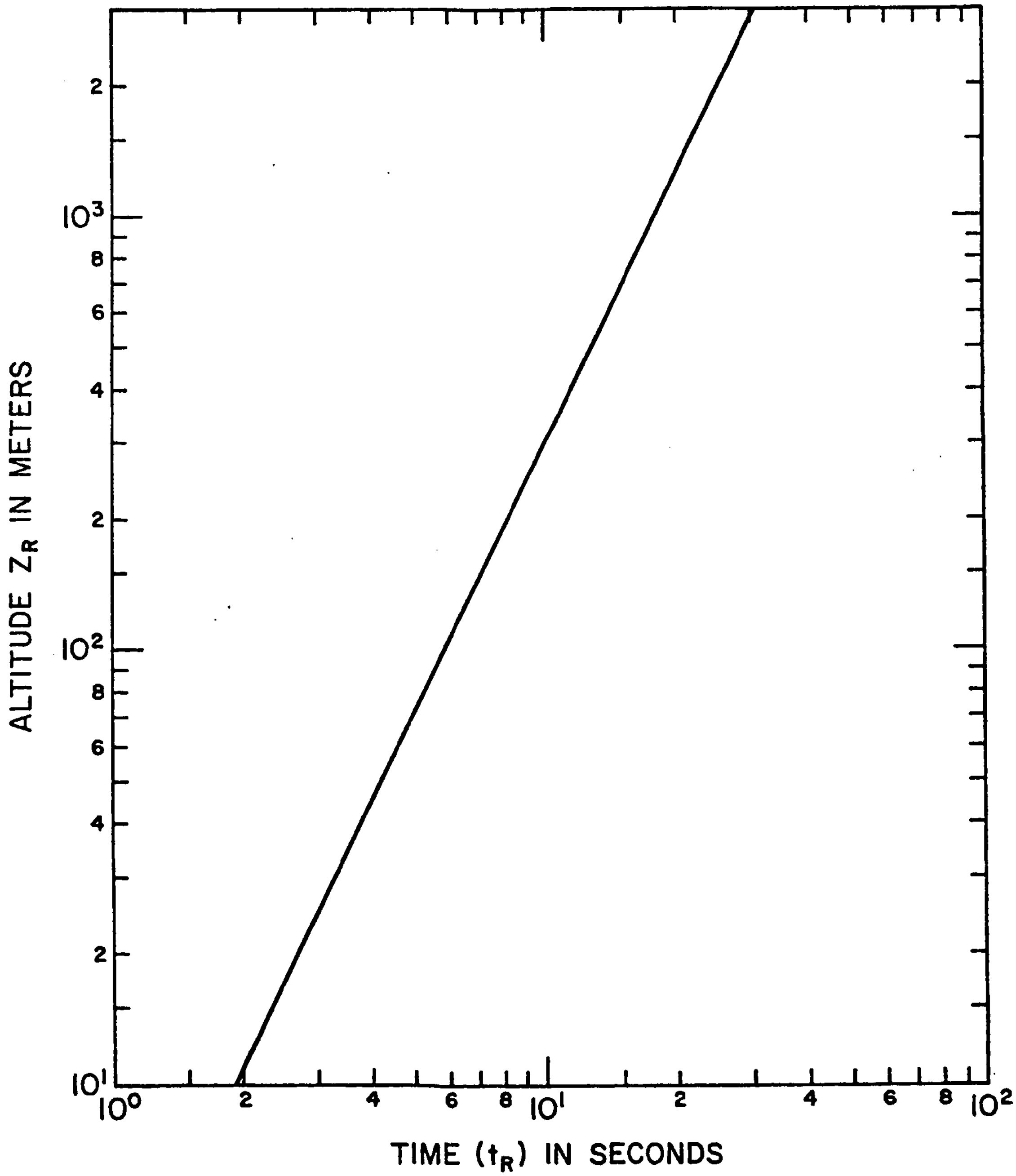

FIGURE 6-1. Height of the Titan III C vehicle as a function of time t_R after ignition.

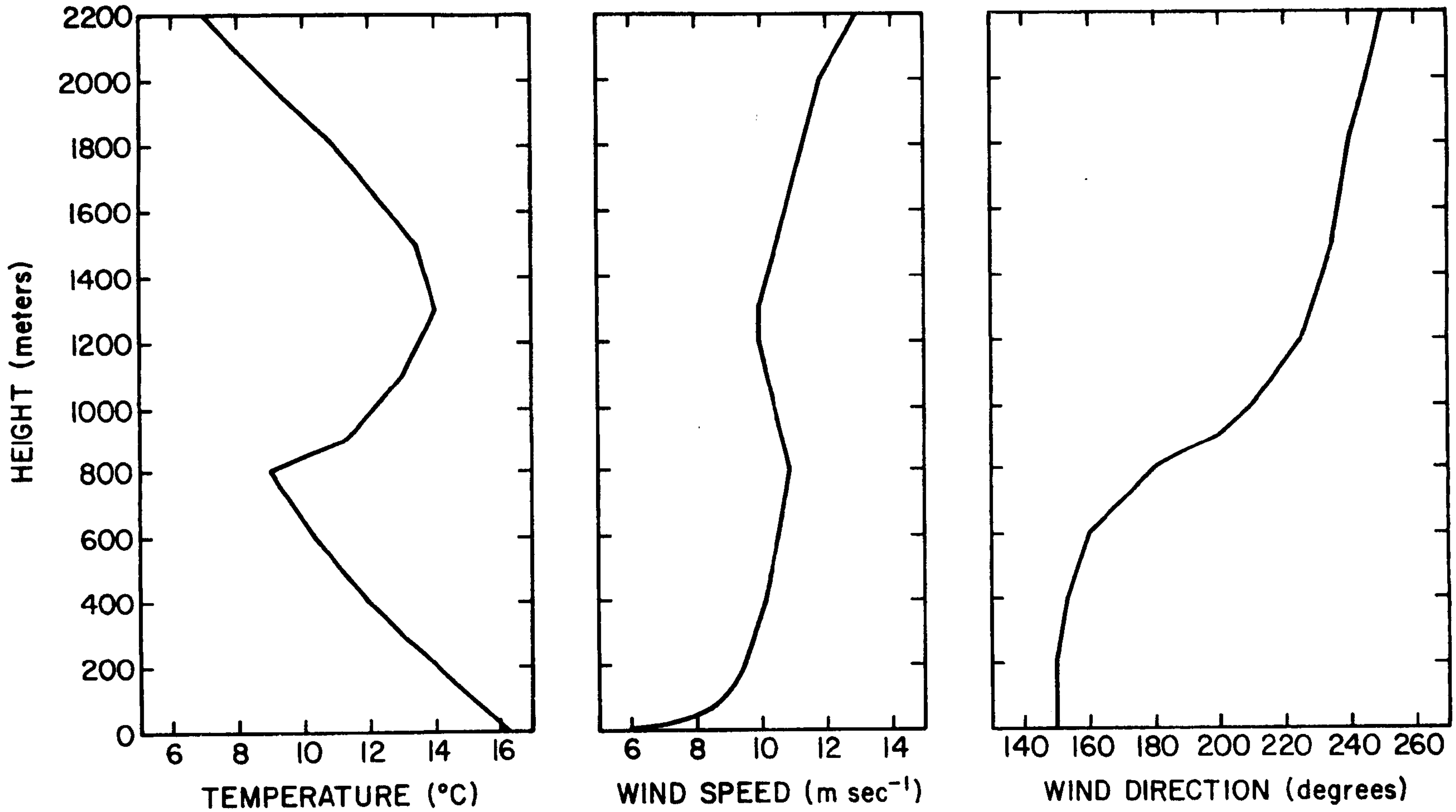

FIGURE 6-2. Vertical profiles of temperature, wind speed and wind direction for a sea-breeze meteorological regime at Kennedy Space Center.

at the top of the layer, then veers more rapidly to the southwest in the capping-inversion above the mixing layer. The temperature, wind speed and wind direction data are inputs used directly in either the calculation of cloud rise or the concentration and dosage models. The turbulence parameters, the standard deviations of the wind azimuth σ'_A and elevation σ'_E angle fluctuations, can be obtained from direct measurements or, in the absence of direct measurements, deduced from the profile measurements such as those presented in Figure 6-2. The procedures used in these example problems to obtain the turbulence parameters are described in Appendix E. Meteorological inputs used in this sample calculation of concentration and dosage and in the cloud rise calculation are given in Table E-1 of Appendix E.

Source Inputs

It follows from the discussion of cloud-rise formulas in Section 3 and the diffusion models in Section 4 that source inputs required for the diffusion model calculations include the stabilization height of the exhaust cloud and initial cloud dimensions, as well as the vertical distribution of exhaust products in the stabilized cloud.

Equation (3-3) was used in the cloud-rise calculation for the normal launch of a Titan III C vehicle because of the stable temperature profile shown in Figure 6-2 and because experience has shown that the nearly-instantaneous cloud-rise formulas are appropriate for use with vehicles with relatively short residence times in the vicinity of the surface. Limited experience has also shown that the entrainment parameter γ_I for Titan III C vehicles is about 0.64. The effective heat available for buoyant cloud rise was calculated from the expression

$$Q_I = \left(Q_F - Q'\right) \; t_R \left\{ z_{mI} \right\} \qquad (6-2)$$

where

Q_F = rate of heat released by burning fuel

$= H \cdot W$

H = heat content of fuel (Table 6-1)

W = fuel expenditure rate (Table 6-1)

Q' = rate heat is used to heat and vaporize deluge water used in cooling the launch complex

$t_R\{z_{mI}\}$ = time required for the rocket to reach the cloud stabilization height

In the cloud-rise calculations for this example, Q' was assigned a value of 1.25×10^9 calories per second, ρ was equal to 1236.2 grams per cubic meter, and c_p was set equal to 0.24 calories per gram per degree Celsius. The vertical gradient of potential temperature was calculated from the expression

$$\frac{\Delta\Phi}{\Delta z} = \frac{\Phi\{z_{mI}\} - \Phi_R}{z_{mI} - z_R} \tag{6-3}$$

where

$\Phi\{z_{mI}\}$ = potential temperature at the cloud stabilization height

$$= T\{z_{mI}\}\left(\frac{1000}{P\{z_{mI}\}}\right)^{0.286}$$

$T\{z_{mI}\}$ = ambient air temperature in degrees Kelvin at the cloud stabilization height z_{mI}

$P\{z_{mI}\}$ = atmospheric pressure in millibars at the cloud stabilization height z_{mI}

Φ_R = potential temperature at the reference height z_R in the surface mixing layer

$$= T\{z_R\}\left(\frac{1000}{P\{z_R\}}\right)^{0.286}$$

$T\{z_R\}$ = ambient air temperature in degrees Kelvin at the reference height z_R in the surface mixing layer

$P\{z_R\}$ = atmospheric pressure in millibars at the reference height z_R in the surface mixing layer

As noted in Section 3, the interdependence between the calculated stabilization height, the potential temperature gradient, and the value of $t_R\{z_{mI}\}$ requires that the stabilization height be obtained through iteration of Equation (3-3). In this example, the calculated stabilization height was found equal to 832 meters with stabilization occurring at about 461 seconds.

Models 3 and 4 were used to calculate the concentration and dosage fields in the surface mixing layer. The calculated concentration and dosage fields near the source are dependent upon which model and source input procedures are selected.

The procedure for calculating the source dimension for application of Model 4 in the surface mixing layer assumes that the cloud radius at any height z is given by the expression

$$r\{z\} = \begin{cases} r_R + \gamma z & ; \ z \leq z_{mI} \\ r_R + \gamma\left(2 z_{mI} - z\right) \geq 200 \text{ meters} & ; \ z > z_{mI} \end{cases} \tag{6-4}$$

In the example calculation, the radius of the cloud at ground level r_R was set equal to zero. For $z > z_{mI}$, the minimum radius of the exhaust plume at stabilization was set equal to 200 meters. These cloud dimensions as a function of height are shown in Figure 6-3.

As indicated by Figure 6-3, the atmosphere was divided into 11 layers for Model 4 calculation—eight layers in the surface mixing layer $z < H_m$ and 3 layers in the inversion above the mixing layer. The cloud was assumed

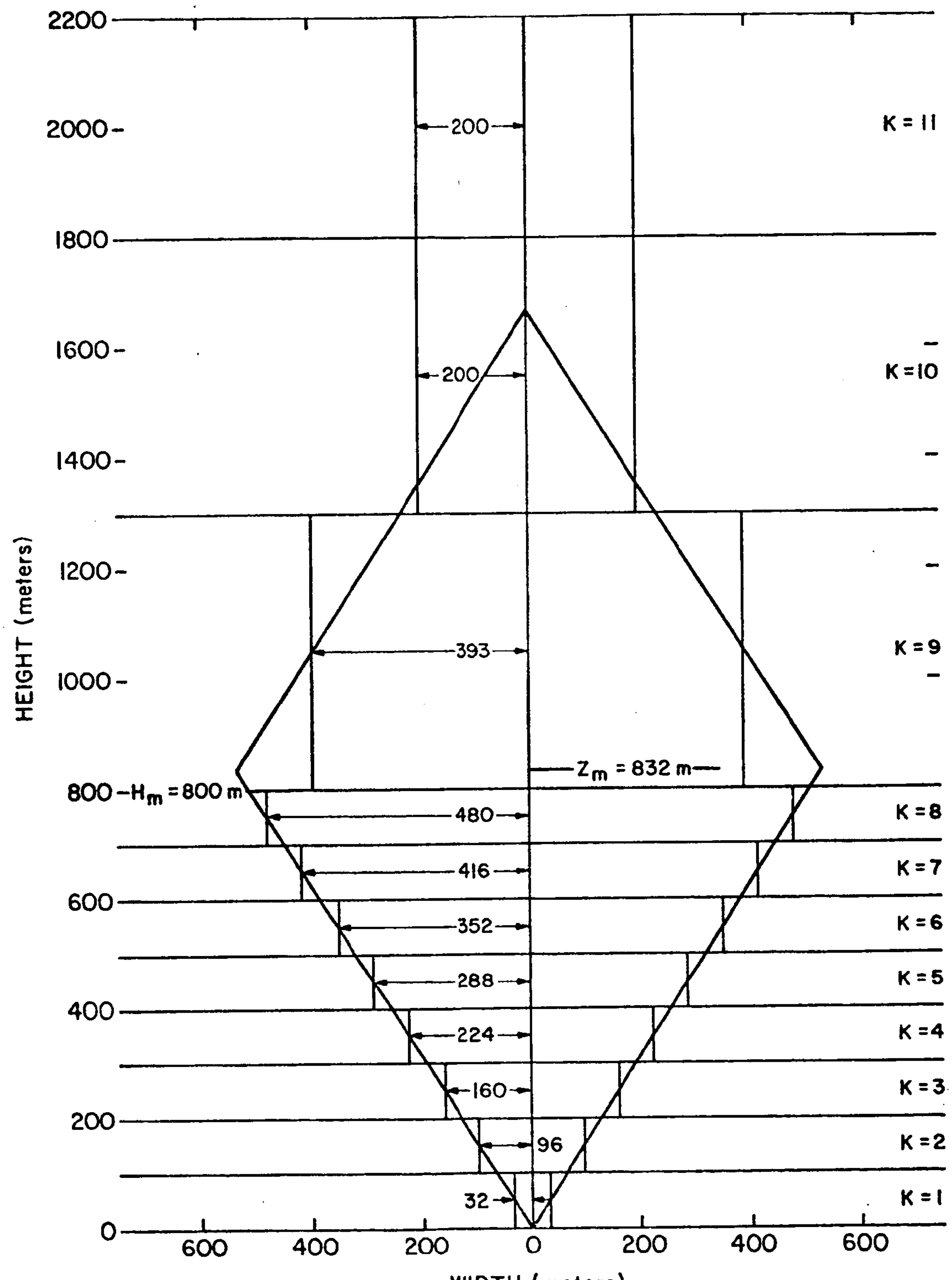

FIGURE 6-3. Dimensions of the stabilized cloud of exhaust products for use with Model 4 calculated for the sea-breeze meteorological regime at Kennedy Space Center. Height of cloud centroid is 832 meters and the surface mixing layer depth is 800 meters.

symmetrical about a vertical axis through the cloud centroid. The alongwind and crosswind source dimensions in each layer were calculated under the following assumptions:

- The distribution of exhaust products within the cloud is Gaussian in the plane of the horizon
- The concentration of exhaust products at a lateral distance of one radius from the cloud vertical axis is 10 percent of the concentration at the vertical axis

Thus, the alongwind and crosswind dimensions are defined in each layer by

$$\sigma_{xo}\{K\} = \sigma_{yo}\{K\} = \begin{cases} \left(r_R + \gamma\, z'\right)/2.15 & ;\ z' \le z_{mI} \\ r_R + \gamma\left(2\, z_{mI} - z'\right)/\, 2.15 \ge 93 \text{ meters} & ;\ z' > z_{mI} \end{cases} \tag{6-5}$$

where

z' = midpoint of the K^{th} layer

$= \left(z_{BK} + z_{TK}\right)/2$

The corresponding vertical source dimension for each layer was calculated from the expression

$$\sigma_{zo}\{K\} = \left(z_{TK} - z_{BK}\right)/\sqrt{12} \tag{6-6}$$

Equation (6-6) assumes that the vertical distribution of material in the K^{th} layer is rectangular.

The distribution of material by weight for the case in which Model 4 was used was determined from the expression for the fraction of material in each of the K layers

$$F\{K\} = \begin{cases} Q \; P\{z_{TK}\} & ; \quad K = 1 \\ Q\left(P\{z_{TK}\} - P\{z_{BK}\}\right) & ; \quad K > 1 \end{cases} \tag{6-7}$$

where

$F\{K\}$ = fraction of the pollutant in the K^{th} layer

Q = total weight of exhaust products in the stabilized ground cloud

$$= \left(Q_R\right)\left(t_R\{z_{mI}\}\right)\left(FM\right) \tag{6-8}$$

Q_R = fuel expenditure rate from Table 6-1

FM = percentage by weight of pollutant material in the fuel from Table 6-1

$$P\{z_{TK}\} = \frac{1}{\sqrt{2\pi}\,\sigma} \int_{-\infty}^{z_{TK}} \exp\left[-\frac{1}{2}\left(\frac{z - z_{mI}}{\sigma}\right)^2\right] dz \tag{6-9}$$

$$= \Phi\left\{\frac{z_{TK} - z_{mI}}{\sigma}\right\}$$

$$\sigma = r\{z = z_{mI}\}/2.15$$

$$P\{z_{BK}\} = \frac{1}{\sqrt{2\pi}\,\sigma} \int_{-\infty}^{z_{BK}} \exp\left[-\frac{1}{2}\left(\frac{z - z_{mI}}{\sigma}\right)^2\right] dz \tag{6-10}$$

$$= \Phi\left\{\frac{z_{BK} - z_{mI}}{\sigma}\right\}$$

$$\Phi(t) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{t} \exp\left(\frac{-\xi^2}{2}\right) d\xi$$

Inspection of Equations (6-9) and (6-10) shows that a Gaussian vertical distribution of material is assumed about the height z_{mI}. Model 4 requires that source strength in each of the K layers be specified per unit height. Since the desired units for concentration are parts per million of HCl and for dosage are parts per million-seconds, the complete expression for the source strength model input for the K^{th} layer is

$$Q_K = \left(\frac{F\{K\}}{(z_{TK} - z_{BK})}\right)\left(\frac{10^3\ mg}{g}\right)\left(\frac{22.4}{M}\right)\left(\frac{T\{z_R\}}{273.16}\right)\left(\frac{1013.2}{P\{z_R\}}\right) \tag{6-11}$$

where M is the molecular weight of the pollutant.

The source model inputs for the Model 4 concentration and dosage calculations are given in Table E-1 of Appendix E.

Model 3, as noted earlier, was also used to calculate concentration and dosage in the surface mixing layer. The procedures for calculating the source dimensions and vertical distribution of material are much simplified when Model 3 is employed in predicting the dosage and concentration fields in the surface mixing layer. In this case, the alongwind, crosswind and vertical source dimensions are given by the expressions

$$\sigma_{xo}\{K\} = \sigma_{yo}\{K\} = r\{z_{mI}\}/2.15 \tag{6-12}$$

$$\sigma_{zo}\{K\} = \begin{cases} \dfrac{H_m - z_{mI} + r\{z_{mI}\}}{4.3} & ; \ H_m \le z_{mI} + r\{z_{mI}\} \\ \\ \dfrac{r\{z_{mI}\}}{2.15} & ; \ H_m > z_{mI} + r\{z_{mI}\} \end{cases} \tag{6-13}$$

where the surface mixing layer is considered as a single layer (K = 1). To use Model 3 in the general case, an effective source height H_{eff} in the surface mixing layer is defined by

$$H_{eff} = \begin{cases} \dfrac{H_m + z_{mI} - r\{z_{mI}\}}{2} & ; \; H_m \le z_{mI} + r\{z_{mI}\} \\[2ex] z_{mI} & ; \; H_m > z_{mI} + r\{z_{mI}\} \end{cases} \tag{6-14}$$

where H_m is the depth of the surface mixing layer. For the sea-breeze meteorological regime, H_{eff} is approximately 550 meters. Figure 6-4 shows the source configuration for this case.

Since Model 3 requires that source strength in the layer be expressed as the total amount of material, the source strength in the mixing layer was calculated from the expression

$$F_K\{K=1\} = \frac{V'}{V_T} Q \tag{6-15}$$

where

V' = volume of the cloud in the surface mixing layer

$$= \begin{cases} \dfrac{\pi}{3}\left(H_m + r\{z_{mI}\} - z_{mI}\right)^2 \left(2r\{z_{mI}\} - H_m + z_{mI}\right); & H_m \le z_{mI} + r\{z_{mI}\} \\[2ex] \dfrac{4}{3}\pi r^3\{z_{mI}\} & ; \; H_m > z_{mI} + r\{z_{mI}\} \end{cases}$$

$$V_T = \frac{4\pi}{3}\left(r\{z_{mI}\}\right)^3$$

and Q is defined by Equation (6-8). Because the desired units are parts per million for concentration and parts per million-seconds for dosage, the source strength for Model 3 is given by

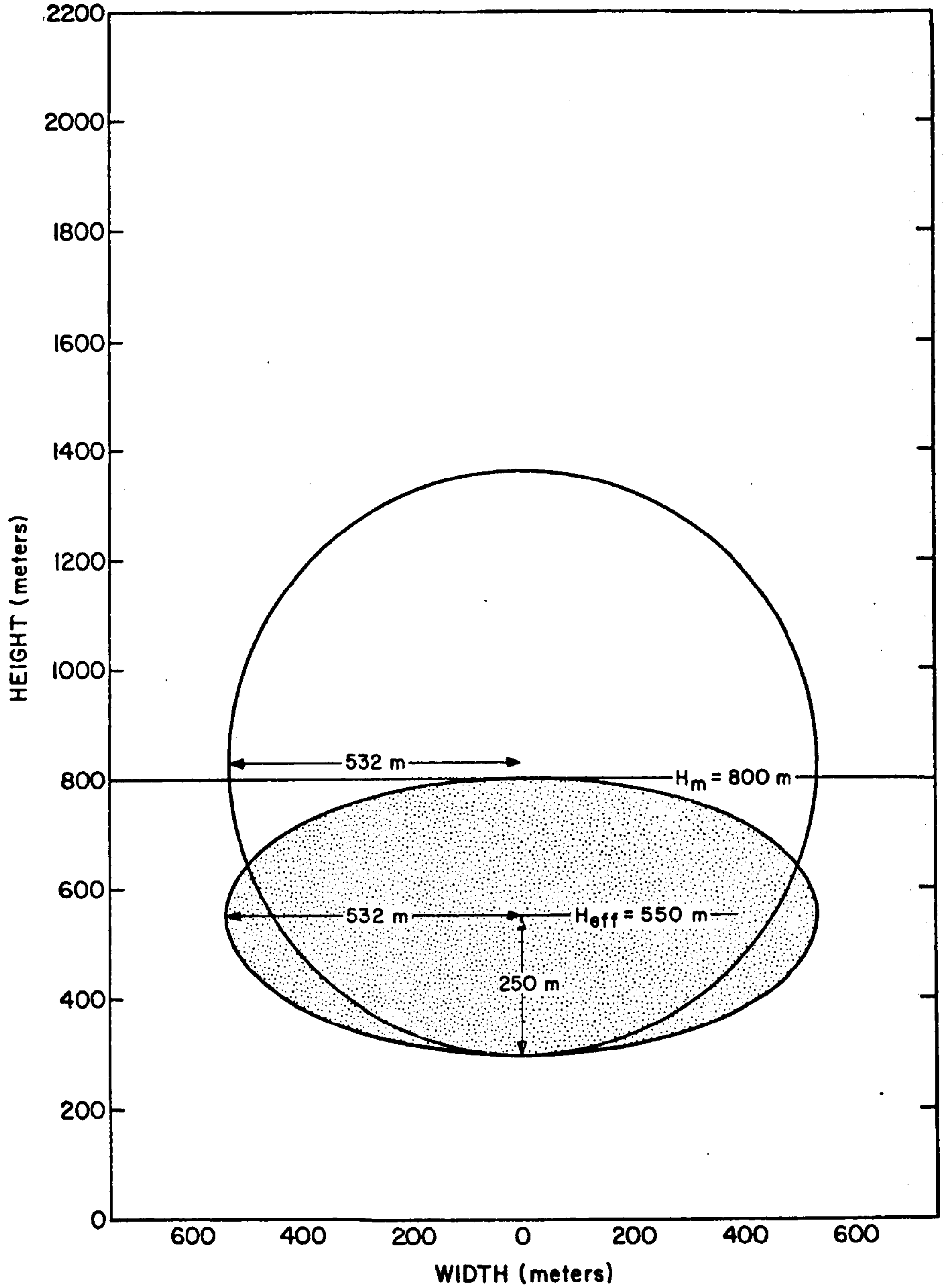

FIGURE 6-4. Dimensions of the stabilized cloud of exhaust products for use with Model 3 calculated for the sea-breeze meteorological regime at Kennedy Space Center. The effective height of the cloud in the surface layer is 550 meters.

$$Q_K\{K-1\} = F_K\{K=1\}\left(\frac{10^3 \text{ mg}}{g}\right)\left(\frac{22.4}{M}\right)\left(\frac{T\{z_R\}}{273.16}\right)\left(\frac{1013.2}{P\{z_R\}}\right) \tag{6-16}$$

The source and meteorological inputs for Model 3 calculations, derived by the procedures outlined above, are given in Table E-2 of Appendix E.

Results of the Calculations

The results of the concentration and dosage calculations for the normal launch of a Titan III C vehicle during a sea-breeze regime at Kennedy Space Center are presented in Figures 6-5 through 6-11.

Figure 6-5 shows maximum centerline concentrations downwind from the point of cloud stabilization. In the figure, the results obtained by applying Model 4 in the surface mixing layer are given by the solid curve and those obtained by applying Model 3 are shown by the dashed curve. Inspection of the curves shown in Figure 6-5 indicates that the initial source configuration assumed in the mixing layer affects the concentrations in only the first few kilometers downwind from the source. It is important to recognize that the detailed knowledge of the vertical distribution of material in the stabilized ground cloud required to accurately apply the multilayer techniques of Model 4 is not available from measurements. Until accurate measurements are made, model calculations of concentration and dosage at distances close to the source are subject to uncertainty. The agreement in the two procedures at distances beyond several kilometers from the source occurs because, at these distances, the cloud is becoming uniformly mixed in the surface layer. A partial computer output listing for this example is given in Section D. 1 of Appendix D.

Figure 6-6 shows the average alongwind concentration calculated at ground-level using Models 3 (dashed curve) and 4 (solid curve) and Figure 6-7

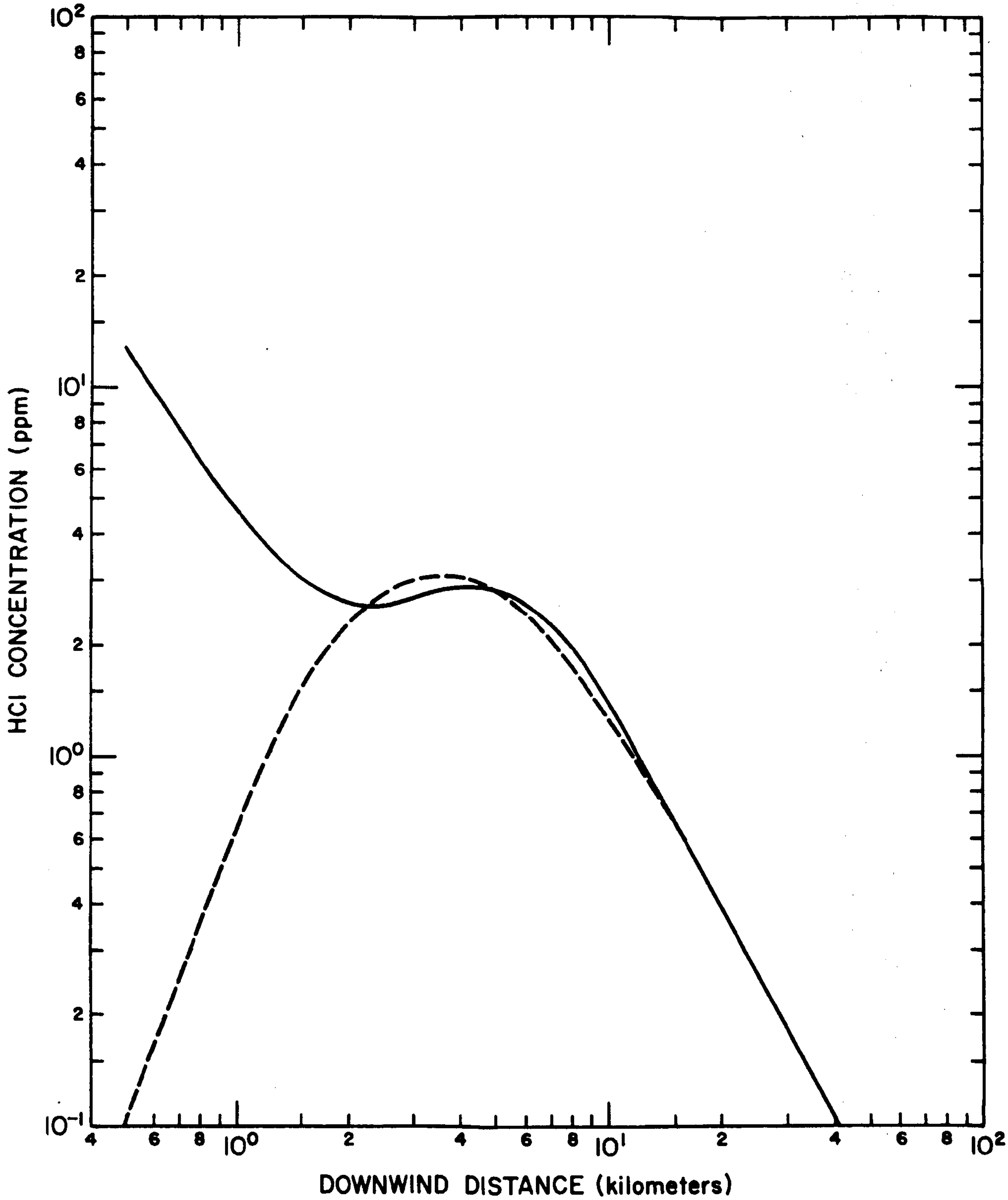

FIGURE 6-5. Maximum centerline concentrations at ground level downwind from the point of cloud stabilization for a normal launch during a sea-breeze meteorological regime at Kennedy Space Center. The dashed profile was calculated using Model 3 and the solid profile was calculated using Model 4.

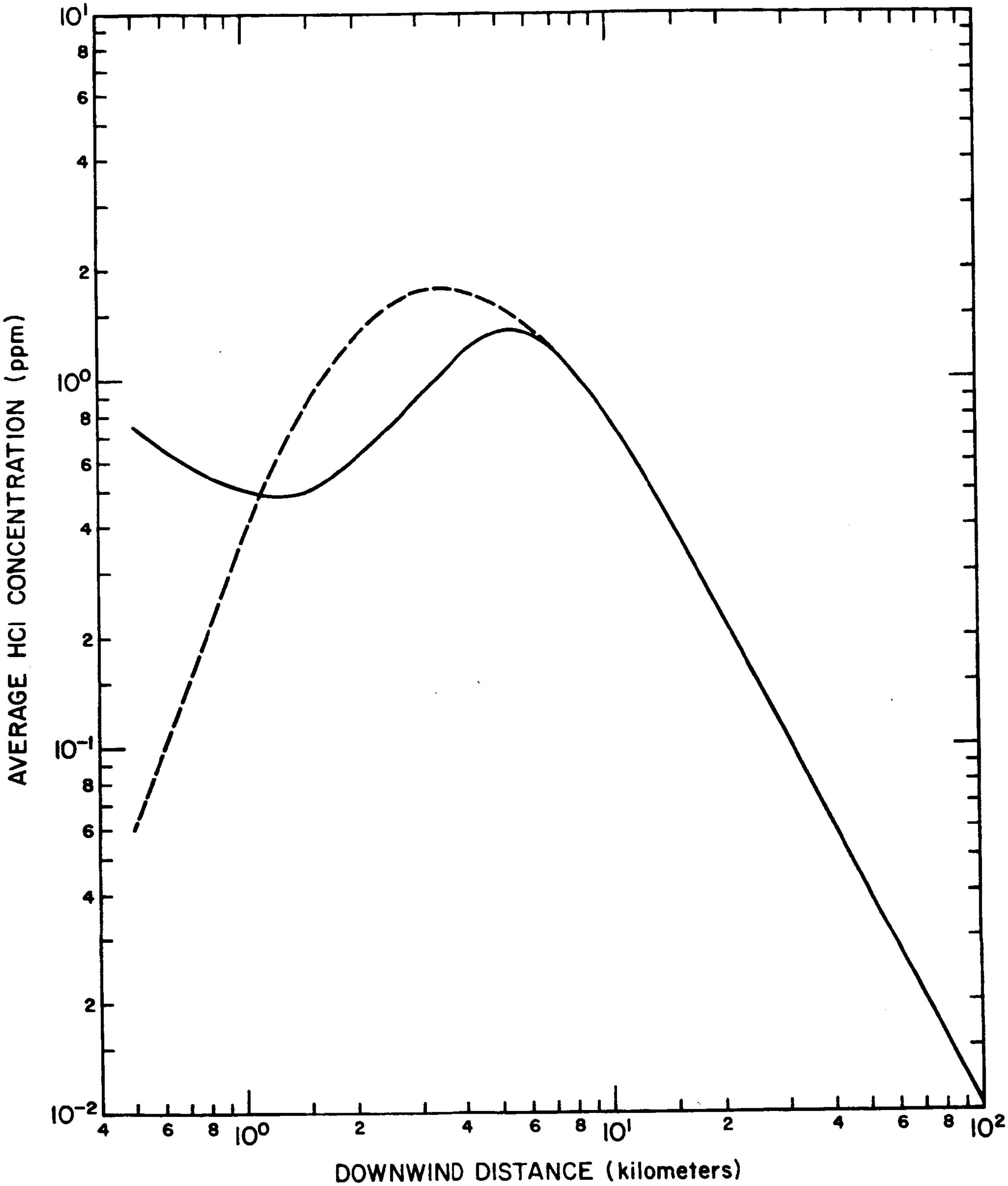

FIGURE 6-6. **Average alongwind concentration at ground level downwind from the point of cloud stabilization for a normal launch during a sea-breeze meteorological regime at Kennedy Space Center. The dashed profile was calculated using Model 3 and the solid profile was calculated using Model 4.**

shows the time mean alongwind concentration for both Models. An averaging time of 10 minutes was used for the time mean concentrations shown in Figure 6-7. In both figures, the concentrations calculated from Models 3 and 4 are equivalent beyond about 7 kilometers downwind from the point of cloud stabilization.

The centerline concentrations, average alongwind concentrations, and time-mean alongwind concentrations at ground level calculated using Model 4 are shown for comparison in Figure 6-8. Inspection of Figure 6-8 shows that, as expected, the 10-minute time-mean concentration is less than the average concentration until the cloud passage time exceeds 10 minutes, which in this case occurs nearly 40 kilometers from the source. A partial computer output listing for this example problem is given in Section D.2 of Appendix D.

Figure 6-9 shows the ground-level maximum concentration field calculated using Model 4 (Equation (4-29)). As expected from inspection of Figure 6-5, the concentration isopleths in Figure 6-9 indicate that HCl concentrations downwind from the source exceed 1 part per million to a distance of about 12 kilometers from the point of cloud stabilization. A partial computer output listing for this example problem is given in Section D.3 of Appendix D.

The computer program was also used to calculate HCl concentrations in the inversion layer above the surface mixing layer. Figure 6-10 shows the results of the calculations using Model 1 at a height of 1300 meters above the surface. In the inversion layer, the 10-minute time-mean concentration exceeds the average alongwind cloud concentration at about 10 kilometers from the source, indicating that cloud passage time beyond 12 kilometers from the source exceeds 10 minutes. Inspection of Figure 6-10 shows that the maximum centerline HCl concentration at 1300 meters above the surface falls to levels below 1 part per million near 10 kilometers from the source.

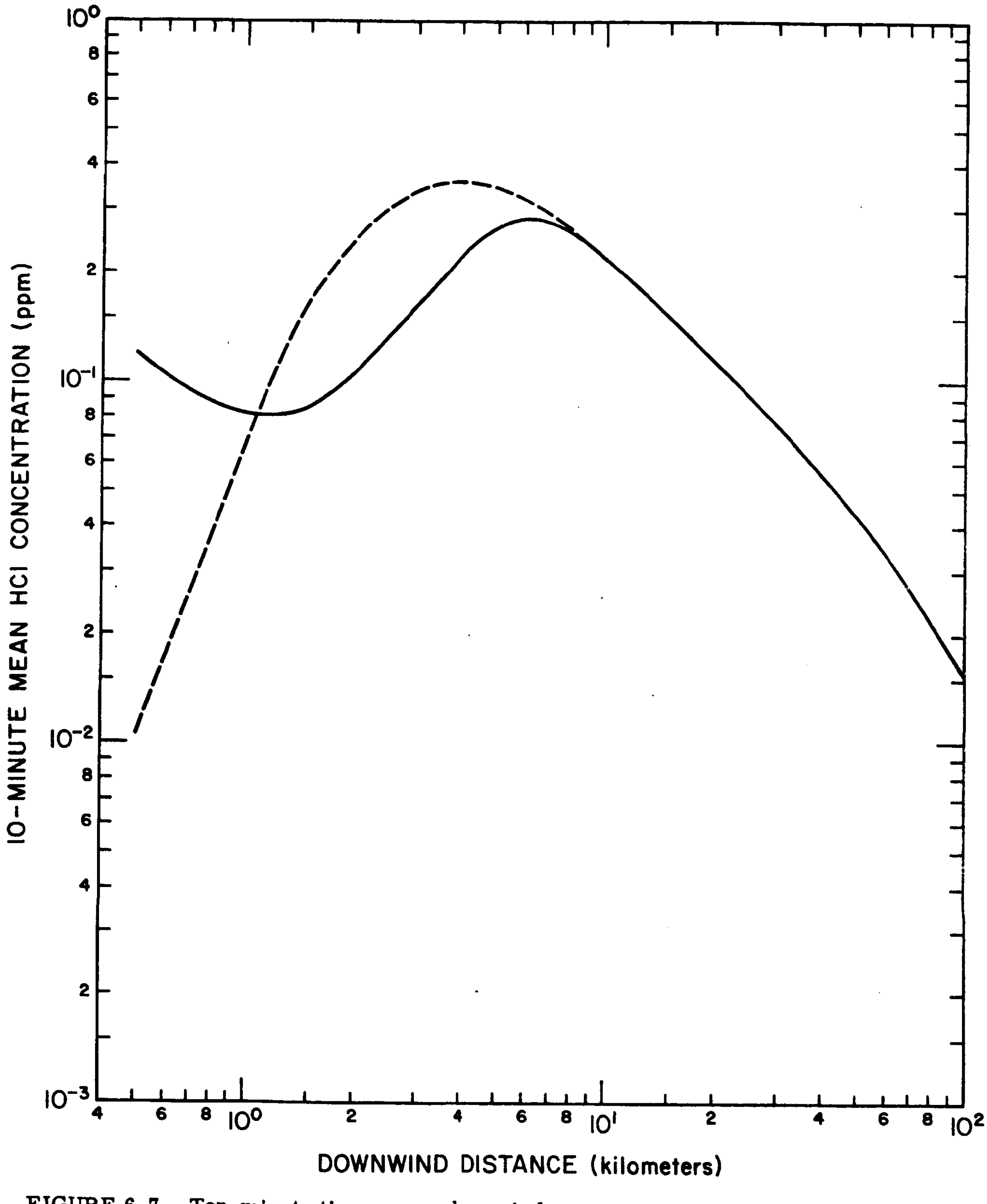

FIGURE 6-7. Ten-minute time mean alongwind concentration at ground level downwind from the point of cloud stabilization for a normal launch during a sea-breeze meteorological regime at Kennedy Space Center. The dashed profile was calculated using Model 3 and the solid profile was calculated using Model 4.

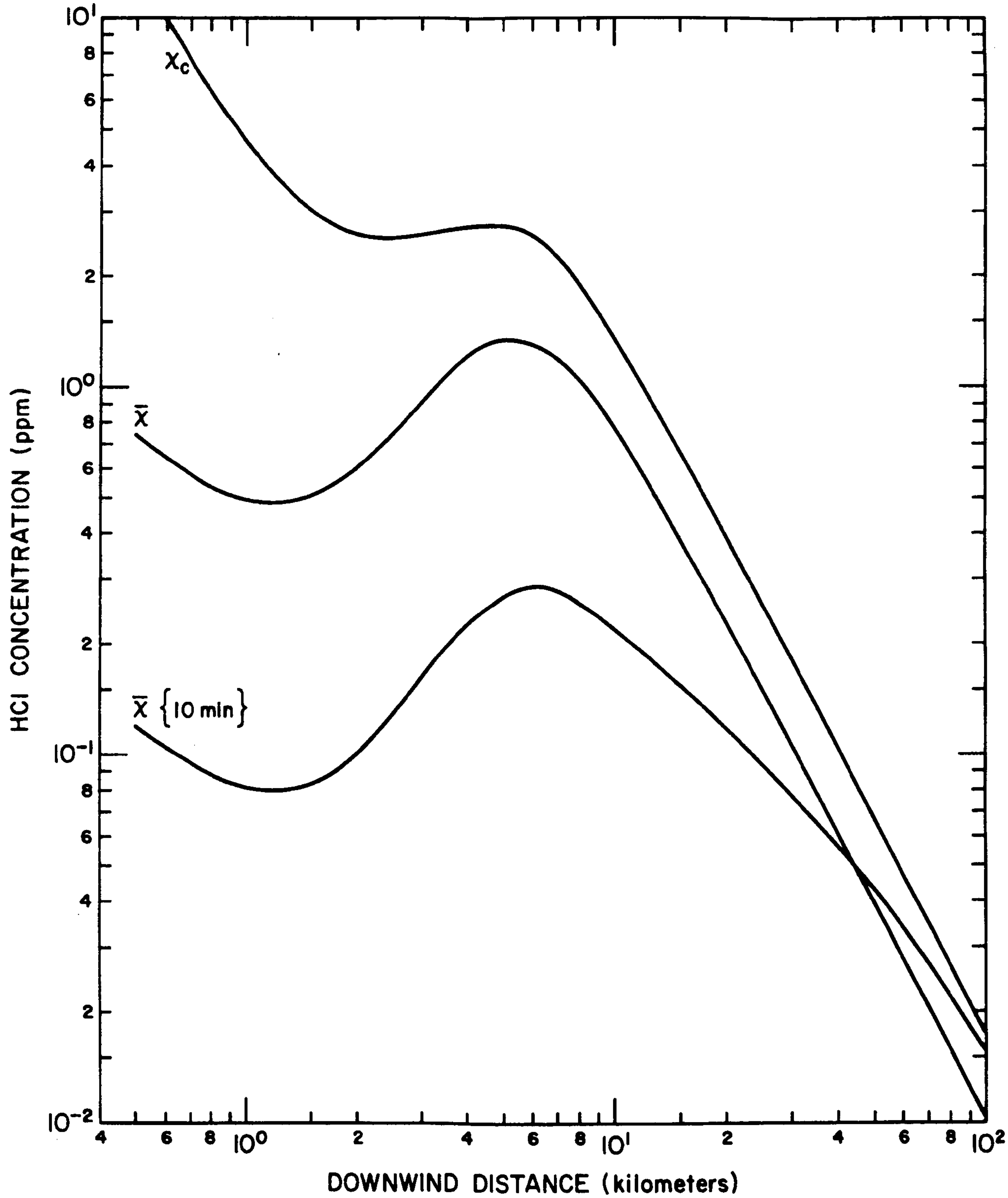

FIGURE 6-8. Maximum centerline, average alongwind, and ten-minute time mean alongwind concentrations at ground level for a normal launch during a sea-breeze meteorological regime at KSC. All profiles were calculated using Model 4.

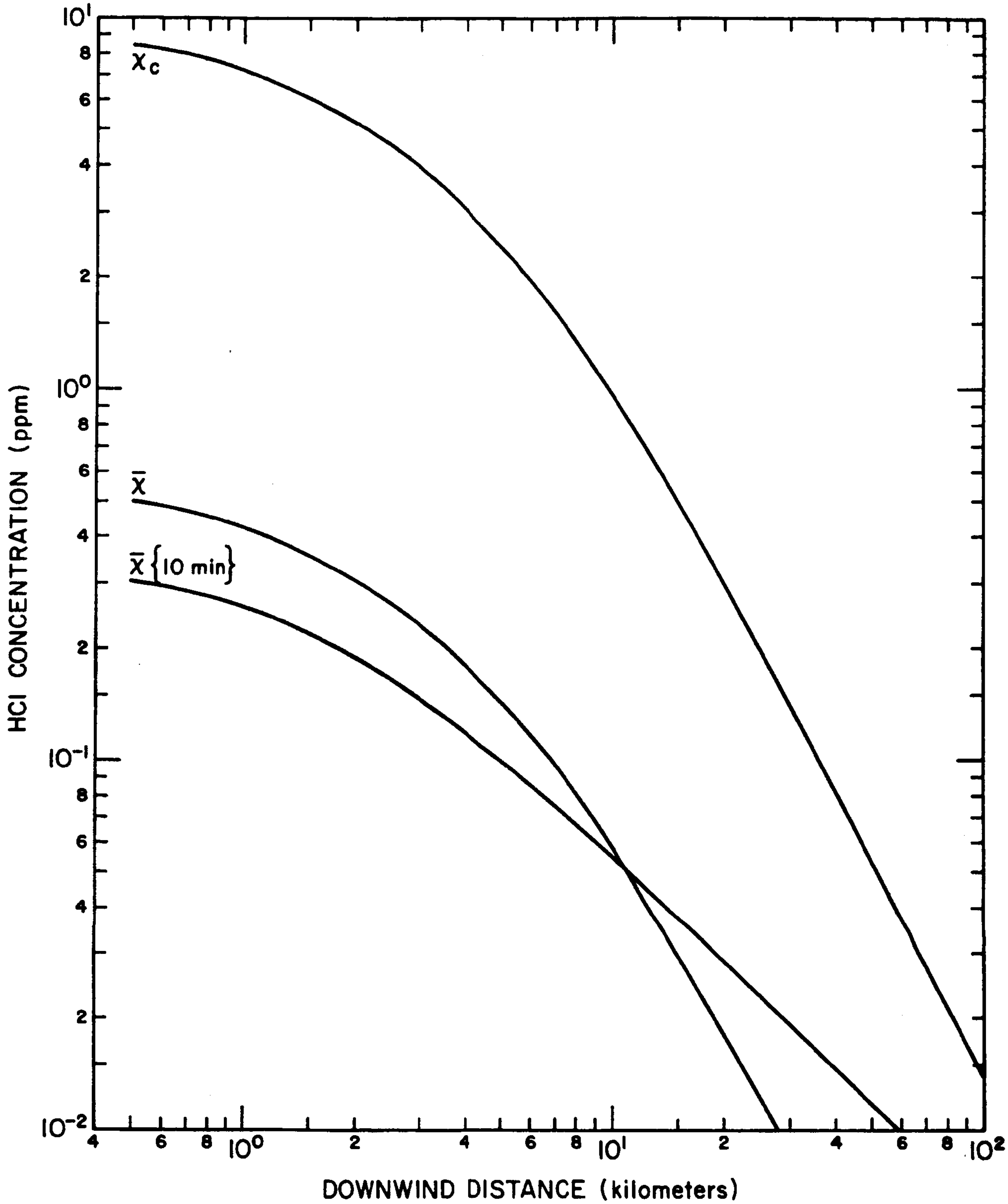

FIGURE 6-10. **Maximum centerline, average alongwind, and ten-minute time mean alongwind concentrations at a height of 1300 meters for a normal launch during a sea-breeze meteorological regime at KSC. All profiles were calculated using Model 1.**

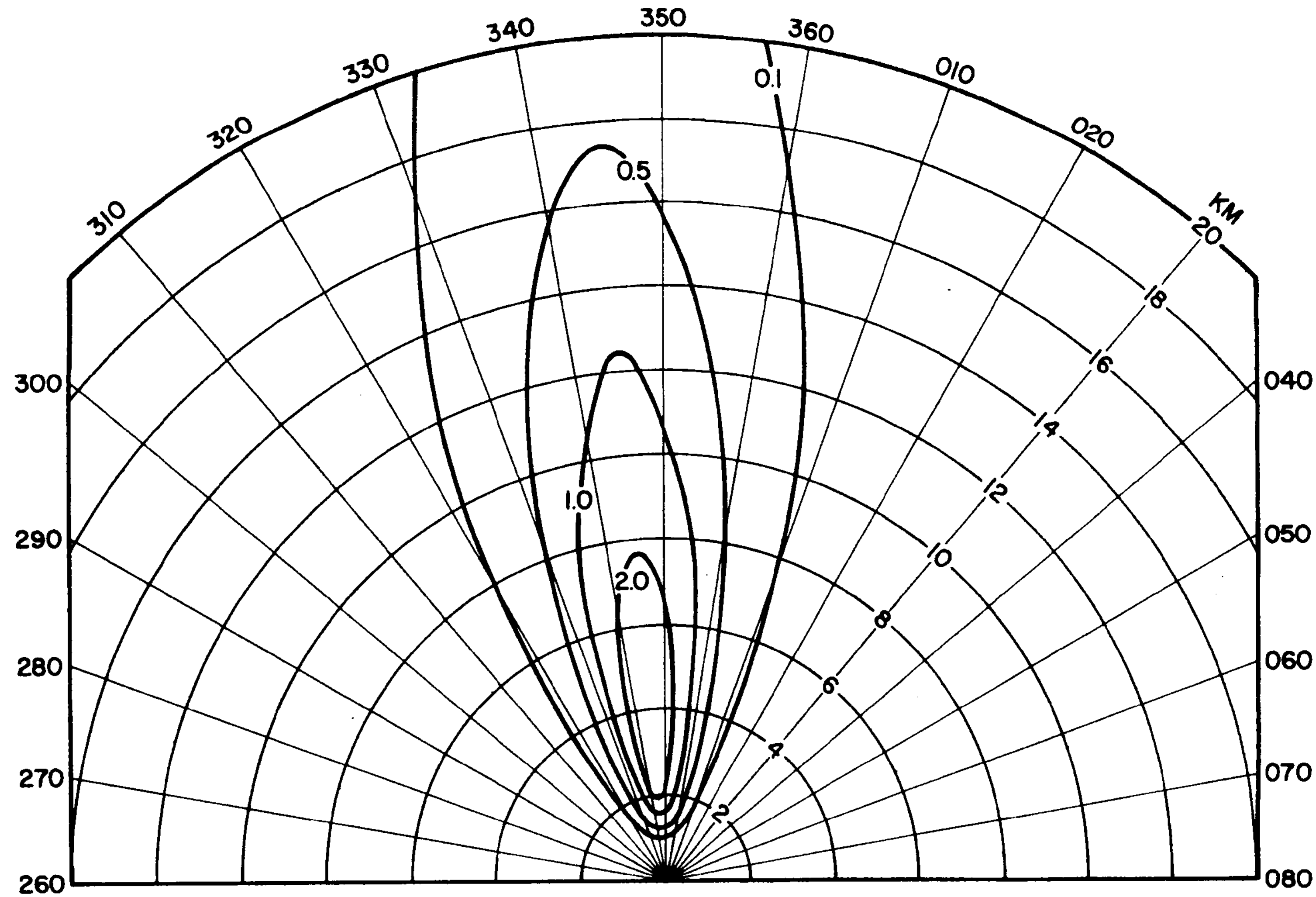

FIGURE 6-9. Isopleths of ground-level maximum HCl concentration downwind from a normal launch during a sea-breeze meteorological regime at Kennedy Space Center. The calculations were made using Model 4. (Units are parts per million.)

Finally, Figure 6-11 shows the centerline ground-level dosage calculated using Models 3 (Equation (4-15)) and 4 (Equation (4-18)).

6.2.2 Deposition by Precipitation Scavenging and Concentration With Cloud Depletion by Scavenging

Meteorological Inputs

The ground-level deposition pattern resulting from precipitation scavenging and the concentration downwind from the launch of a Titan III C vehicle during the time of a cold-front passage at Kennedy Space Center were calculated to illustrate the use of Equation (4-34). Meteorological profiles of temperature, wind speed, and wind direction obtained during the cold-front passage are shown in Figure 6-12. The temperature profile in Figure 6-12 indicates a vertical lapse rate of temperature which results in a positive potential temperature gradient. Wind speed increases throughout the lowest 2 kilometers of the atmosphere and wind direction veers at a nearly constant rate.

The removal of aerosols and gases from the atmosphere by scavenging has long been understood in a qualitative sense, but quantitative knowledge is still limited. The value of Λ, the washout coefficient appearing in Equation (4-34), is dependent on factors such as the rainfall rate, the drop-size distribution of the rain, and the physical and chemical nature of the aerosol or gas being removed.

The washout coefficient for particles of diameter p is given by

$$\begin{aligned} \Lambda &= \int_0^\infty N\{a\}\ U\{a\}\ E\{a,p\}\ A\{a\}\ da \\ &= \int_0^\infty F\{a\}\ E\{a,p\}\ A\{a\}\ da \end{aligned} \qquad (6\text{-}17)$$

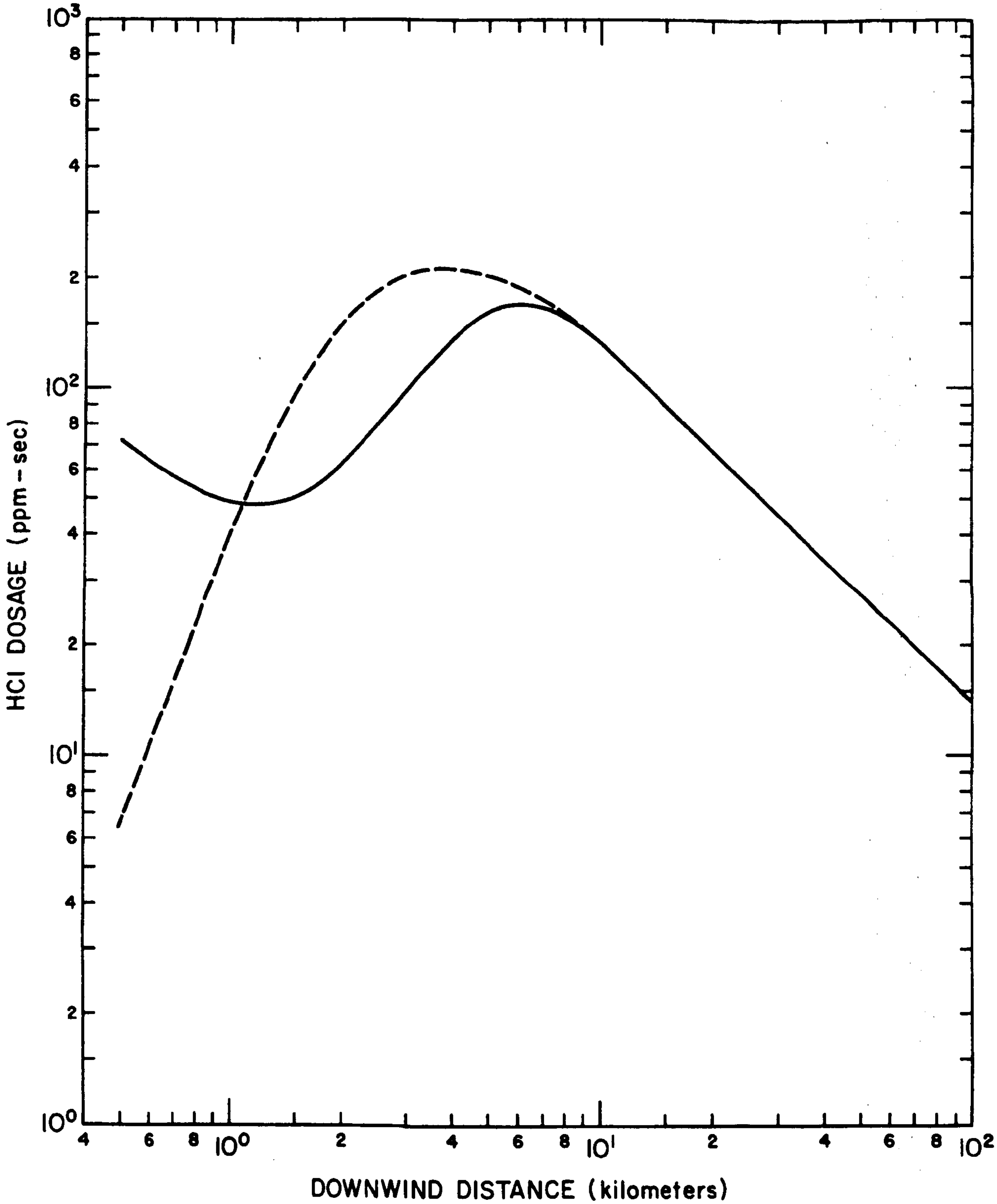

FIGURE 6-11. **Centerline dosage at ground level downwind from the point of cloud stabilization for a normal launch during a sea-breeze meteorological regime at KSC. The dashed profile was calculated using Model 3 and the solid profile was calculated using Model 4.**

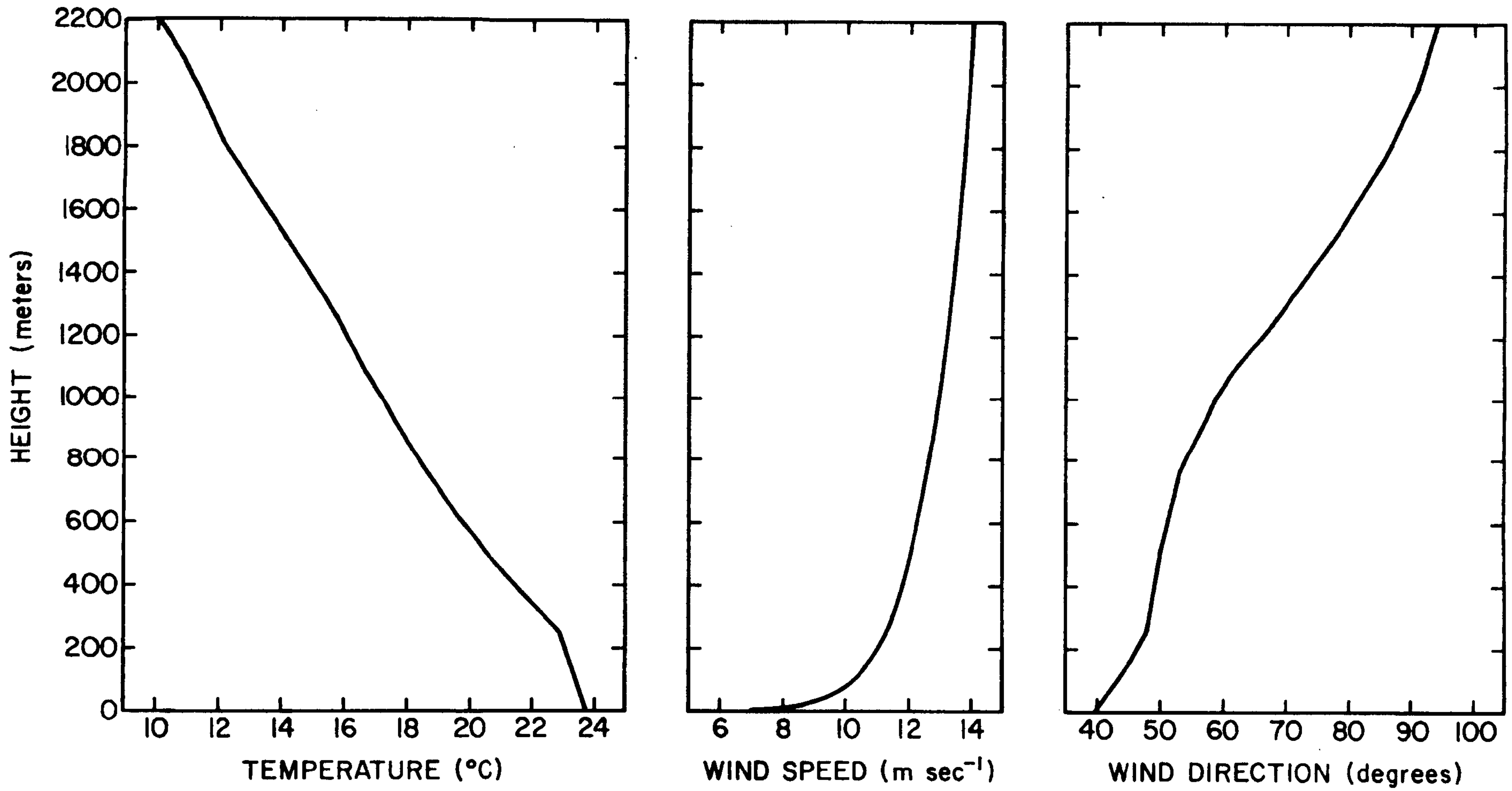

FIGURE 6-12. Vertical profiles of temperature, wind speed and wind direction during the passage of a cold front at Kennedy Space Center.

where

$N\{a\}$ = number of drops with diameters in the range from a to a + da

$U\{a\}$ = fall velocity of droplets with diameter a

$E\{a, p\}$ = the collection efficiency of drops with diameter a for particles of diameter p

$A\{a\}$ = $\pi/4\ a^2$, the areal cross-section of the drop

$F\{a\}$ = the flux of drops with diameters in the range from a to a + da

The collection efficiency E is the quantity which is the most difficult to specify. It is usually calculated from inertial capture theory, leading to the result that collection is proportional to the ratio of the target diameter to the drop diameter. Unfortunately, this theory leads to the erroneous conclusion that the collection efficiency is near zero for gases. In reality, factors such as electrical attraction and solubility lead to high collection efficiencies for some gases, and particles of one micron diameter have been experimentally observed to have washout coefficients an order of magnitude larger than predicted by inertial capture theory (Dana, 1970).

Equation (6-17) may be rewritten in the form

$$\Lambda = \bar{E}\left[\frac{\pi}{4}\int_0^\infty F\{a\}\, a^2\, da\right] = \bar{E}\,\alpha \qquad (6\text{-}18)$$

where $\bar{E}$ is the mean collection efficiency for the given raindrop size spectrum and the specific aerosol or gas. In field tests, Dana (1970) found the ratio of α to the rainfall rate R to be nearly constant. Dana determined the average value of α/R to be 1.6 (mm^{-1}), with observed values ranging from 1.4 to 1.8. Thus, the most difficult problem in determining washout rates is to specify the mean collection efficiency for a given aerosol or gas and raindrop size spectrum. These mean collection efficiencies will probably have to be determined empirically for gases and submicron particulates.

Experimental studies of washout coefficients for gases have largely been confined to major atmospheric pollutants such as SO_2, and there are little or no data regarding HCl washout. However, because of the well-known affinity of HCl for water, a mean collection efficiency of unity would seem to be reasonable. Washout coefficients for HCl may then be estimated on the basis of rainfall rates using Dana's average α/R value of 1.6. For example, a typical rainfall rate for Florida summer showers is 15 millimeters per hour (Miller and Eden, 1972), leading to a washout coefficient Λ of 6.667×10^{-3} sec^{-1} for HCl. This value of Λ was used in the example calculations. The remaining meteorological input parameters used in the calculations are given in Table E-3 of Appendix E.

Source Inputs

The same procedures used in deriving the source inputs for Model 4 calculations for the sea-breeze regime were used to calculate the inputs for the precipitation scavenging example. In this case, the height z_{mI}, also calculated using Equation (3-3), was found to be about 675 meters and the time of cloud stabilization was equal to about 317 seconds. The cloud dimensions for this calculation are shown in Figure 6-13. The source strength for the calculation of deposition by scavenging was expressed in units of milligrams per meter of height in the layer to yield deposition in units of milligrams per square meter. That is, source strength in the K^{th} layer was obtained from the expression

$$Q_K = \frac{F\{K\}}{\left(z_{TK} - z_{BK}\right)} \tag{6-19}$$

where $F\{K\}$ is defined by Equation (6-7). For the calculation of concentration with cloud depletion, Equation (6-11) was used to define Q_K so that concentration units would be parts per million HCl. The source input parameters for this example are given in Table E-3 of Appendix E.

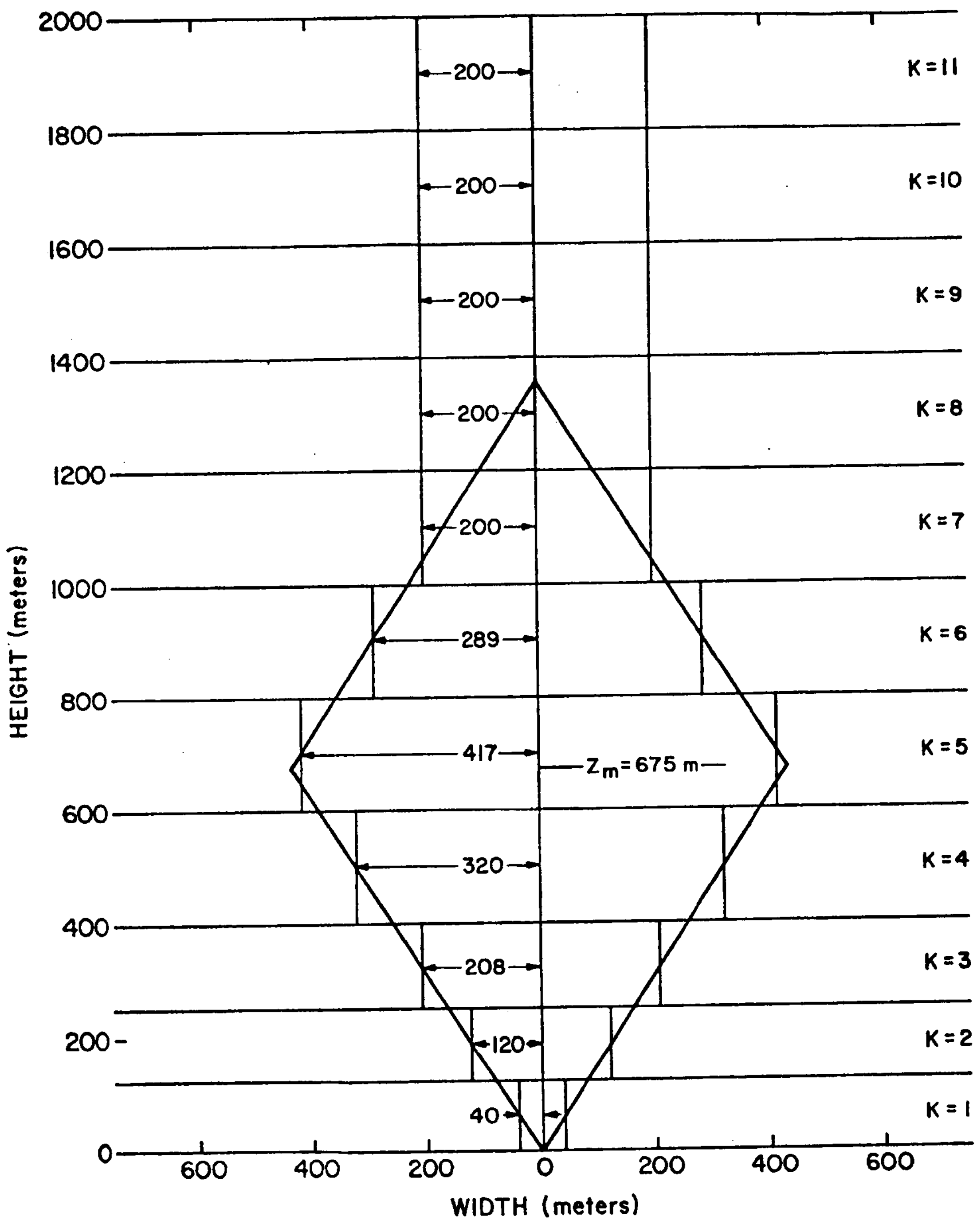

FIGURE 6-13. Dimensions of the stabilized ground cloud of exhaust products from a normal launch calculated for the prediction of ground-level deposition due to precipitation scavenging and gravitational deposition during the passage of a cold front at KSC.

Results of the Calculations

The results of the calculation of ground-level deposition of HCl due to precipitation scavenging are shown in Figure 6-14. Figure 6-15 shows the corresponding ground-level concentrations with precipitation occurring.

As indicated by Figure 6-14, deposition due to scavenging was calculated for precipitation beginning at times t_1 ranging from 394 to 6297 seconds after cloud stabilization, corresponding to cloud travel distances of 5 to 80 kilometers downwind from the source. The solid line connecting the peaks of the deposition curves represents the maximum deposition of HCl due to precipitation scavenging that would be expected to occur downwind from the launch site under the specified meteorological conditions.

Figure 6-15 shows the air concentration at ground level with precipitation beginning at the same times t_1 used to obtain the deposition curves in Figure 6-14. Inspection of the concentration profiles shows that the rather high rainfall rate assumed in the calculation is extremely effective in reducing the air concentration of HCl.

6.2.3 Gravitational Deposition

Meteorological Inputs

The ground-level deposition pattern resulting from the gravitational deposition of Al_2O_3 downwind from the launch of a Titan III C vehicle during the time of a cold-front passage at KSC was calculated to illustrate the use of Equation (4-36). The meteorological profiles for this example are the same as those used in the example discussed in Section 6.2.2 above and illustrated in Figure 6-12.

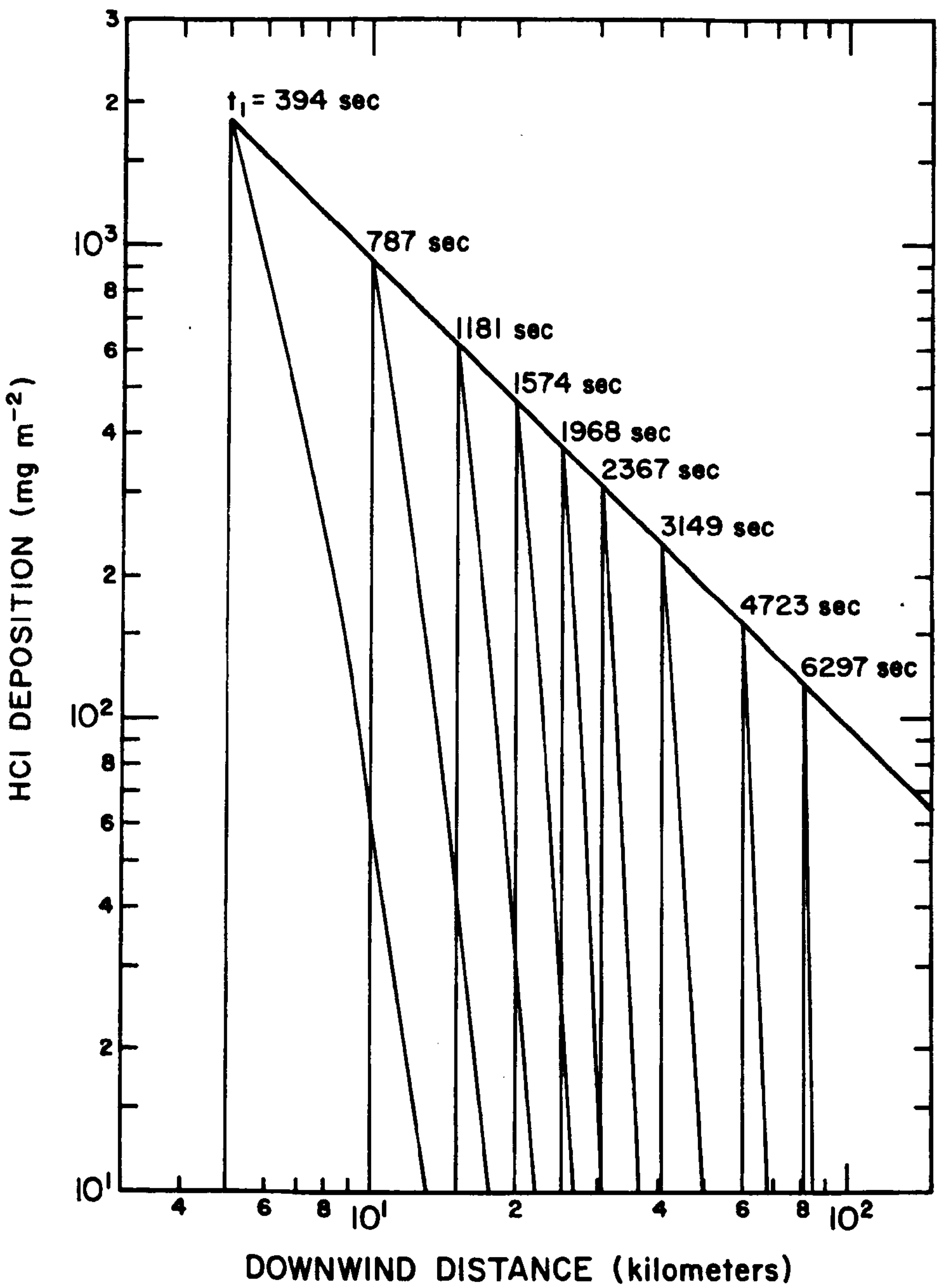

FIGURE 6-14. **Maximum ground-level deposition of HCl due to precipitation scavenging downwind from the point of cloud stabilization for a normal launch during the passage of a cold front at KSC and for various times t_1, when precipitation begins.**

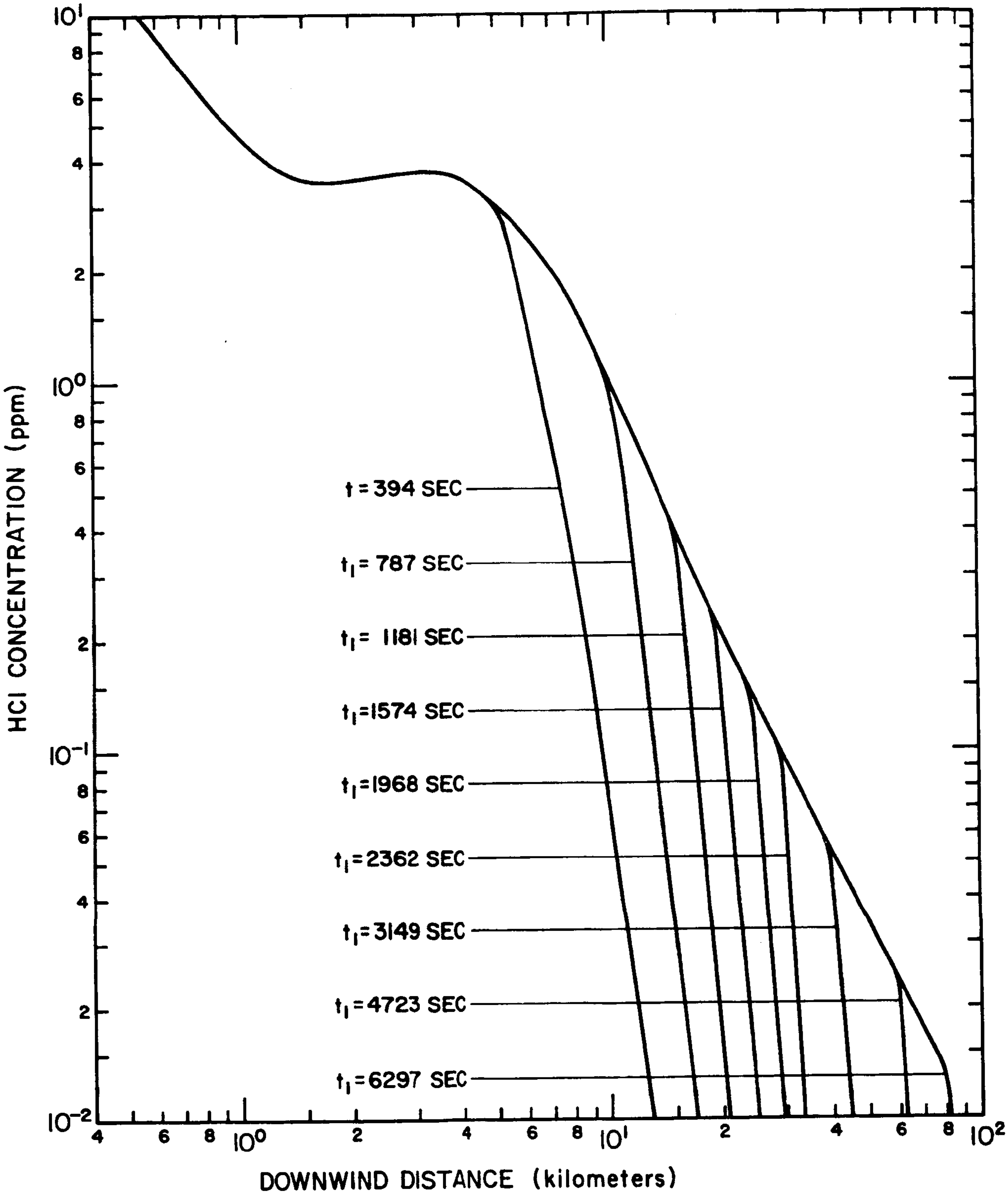

FIGURE 6-15. Maximum centerline concentration of HCl at ground level downwind from the point of cloud stabilization for a normal launch during the passage of a cold front at KSC. Profiles show the reduction in air concentration of HCl due to precipitation scavenging for precipitation beginning at times t_1.

Source Inputs

The initial vertical distribution of material in the stabilized ground cloud and the initial cloud dimensions for this example problem are the same as those for the precipitation scavenging example in Section 6.2.2. In this case, the source strength must be expressed in units of milligrams per meter of height in the layer to yield deposition units of milligrams per square meter.

The terminal fall velocity V_s and fraction of material f_i having fall velocities V_s must be specified for use of Equation (4-36). The size distribution of Al_2O_3 particles in the exhaust of solid rocket motors was not known, so the logarithmic distribution shown in Figure 6-16 was assumed to represent the distribution. As indicated by Figure 6-16, 98 percent of the mass of Al_2O_3 is assumed to have particle diameters less than 150 micrometers, and the mean mass diameter of the distribution is about 12.3 micrometers. The ten class frequency intervals and the geometric mean particle diameters in each interval are indicated in the figure. Terminal fall velocities for these mean diameters were calculated using procedures outlined by McDonald (1960) for spherical particles. The fall velocities V_s and fraction of material in each frequency interval f_i are given in Table 6-2. The meteorological and source model inputs for this example are given in Table E-4 of Appendix E.

Results of the Calculations

The results of the calculations of gravitational deposition are shown in Figure 6-17, which shows isopleths of Al_2O_3 deposition in units of milligrams per square meter. The fan-shaped deposition pattern is caused by the wind direction shear between the surface and 2000 meters which acts to spread the particles as they fall.

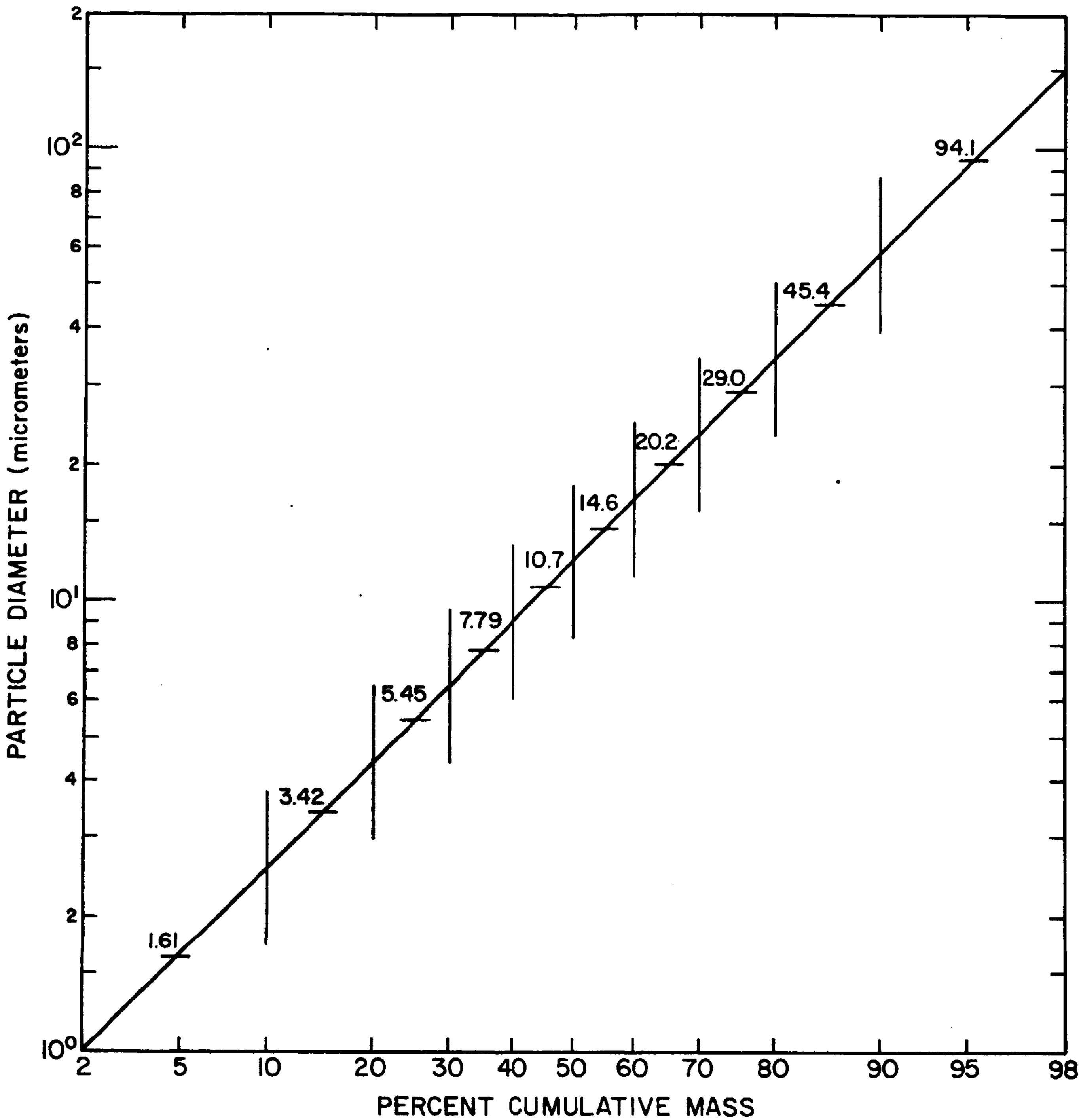

FIGURE 6-16. Cumulative mass distribution versus particle diameters used in the calculation of gravitational deposition downwind from a normal launch. Vertical lines indicate the class frequency intervals used in the calculation and the numbers refer to the mean mass diameter in the interval.

TABLE 6-2

CLASS INTERVAL OF PARTICLE DIAMETERS, MASS FRACTION f_i IN THE INTERVAL, AND TERMINAL FALL VELOCITY V_s

Diameter Class Interval (micrometers)	Mass Mean Radius (micrometers)	Mass Fraction (percent)	Terminal Fall Velocity (meters second^{-1})
0 - 2.6	0.805	10	3×10^{-4}
2.7 - 4.5	1.71	10	1.4×10^{-3}
4.6 - 6.6	2.73	10	3.5×10^{-3}
6.7 - 9.2	3.90	10	7.2×10^{-3}
9.3 - 12.5	5.36	10	1.4×10^{-2}
12.6 - 17.0	7.29	10	2.5×10^{-2}
17.1 - 24.0	10.05	10	4.8×10^{-2}
24.1 - 35.0	14.49	10	1.0×10^{-1}
35.1 - 59.0	22.72	10	2.5×10^{-1}
59.1 - 150	47.04	10	7.0×10^{-1}

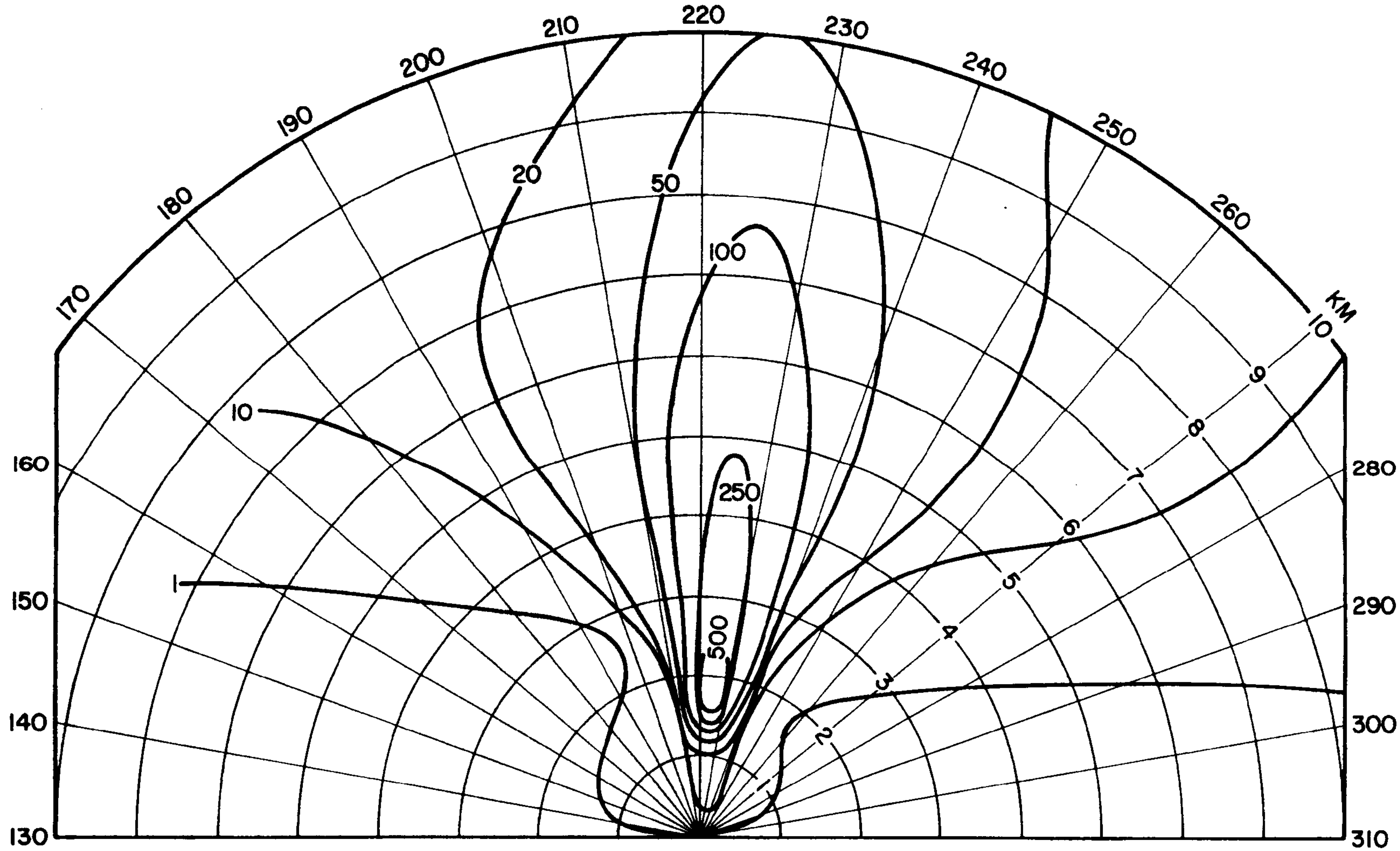

FIGURE 6-17. Isopleths of ground-level deposition of Al_2O_3 in units of micrograms per square meter downwind from a normal launch during the passage of a cold front at KSC.

6.3 ABNORMAL LAUNCH

Only one type of abnormal launch was considered in the example problems of this report. Concentration and dosage were calculated, using both Models 3 and 4, for an on-pad abort in which one solid engine of a Titan III C zero stage fails to ignite and the other engine burns over a normal firing period of 112 seconds. The vehicle was assumed to be restrained on the pad with the other stages of the vehicle unaffected by the abort and not contributing to the combustion products or heat released to the atmosphere during the abort.

Meteorological Inputs

The meteorological inputs for the on-pad abort example were selected from rawinsonde and tower data taken about one day after a cold front passage at KSC. The vertical profiles of temperature, wind speed and wind direction for this meteorological regime are shown in Figure 6-18. As indicated by inspection of the temperature profile, the mixing layer extends to about 1400 meters above the surface. The wind speed increases from 6 meters per second near the surface to 11 meters per second at 800 meters above the surface, then remains nearly constant to a height of 1400 meters. The wind speed decreases in the inversion above the surface mixing layer. The wind direction backs with height from about 80 degrees at the surface to 55 degrees at the base of the inversion. The meteorological parameters selected from these profiles and used in the concentration and dosage calculations, as well as the cloud rise calculation, are given in Table E-5 of Appendix E for application of Model 4 and in Table E-6 for application of Model 3.

Source Inputs

Equation (3-6) was used in the calculation of the cloud rise from this assumed on-pad abort situation because of the longer time required for the complete burn of the single engine. We have no measurements to verify calculations of cloud

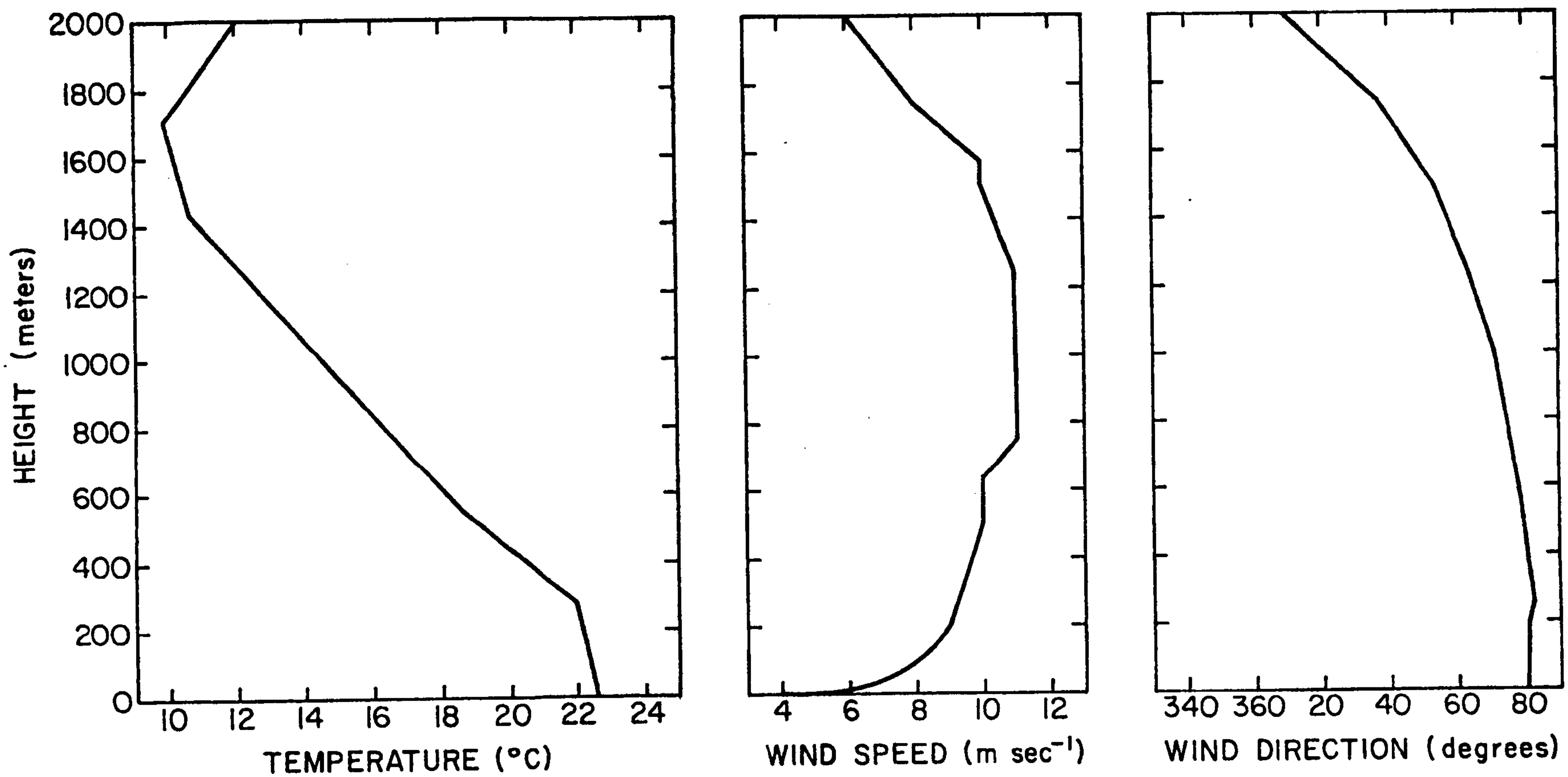

FIGURE 6-18. Vertical profiles of temperature, wind speed and wind direction after the passage of a cold front at Kennedy Space Center.

rise from on-pad aborts of this type. A value of the entrainment parameter γ_c equal 0.5 was selected for use in Equation (3-6) because experience has shown this value to be appropriate for longer vehicle emission times in the vicinity of the surface. The effective heat rate available for buoyant cloud rise was calculated from the expression

$$Q_c = (W \cdot H) - Q' \qquad (6\text{-}20)$$

where W is the fuel expenditure rate for the abnormal launch and H is the heat content (see Table 6-1). In this case, Q', the heat loss due to the heating and vaporization of the deluge water, was set equal to 4.63×10^8 calories per second. In the plume rise calculation ρ was equal to 1197.1 grams per cubic meter, c_p was set equal to 0.24 calories per gram per degree Celsius, and $\bar{u}$ was assumed equal to 9.3 meters per second. The initial cloud radius at the surface r_R was set equal to zero. The iteration of Equation (3-6) using these values and the potential temperature gradient yielded an effective cloud rise z_{mc} of 1132 meters with stabilization occurring at about 450 seconds. The total weight of pollutant in the cloud formed by the abnormal launch was calculated from the expression

$$Q = (W)\ (FM)\ (112 \text{ seconds}) \qquad (6\text{-}21)$$

where W is the fuel expenditure rate for an abnormal launch and FM is the percentage by weight of pollutant material in the fuel. The fraction of pollutant material in the K^{th} layer $F\{K\}$ is then obtained using Equation (6-7) above.

As noted above, both Model 3 and Model 4 were used in this example calculation. Dimensions of the stabilized cloud for applications of Model 4 in the surface mixing layer, calculated according to the procedures outlined in Section 6.2.1, are illustrated in Figure 6-19. The effective source height calculated from Equation (6-14) with z_{mc} substituted for z_{mI} yielded H_{eff} equal 983 meters. The

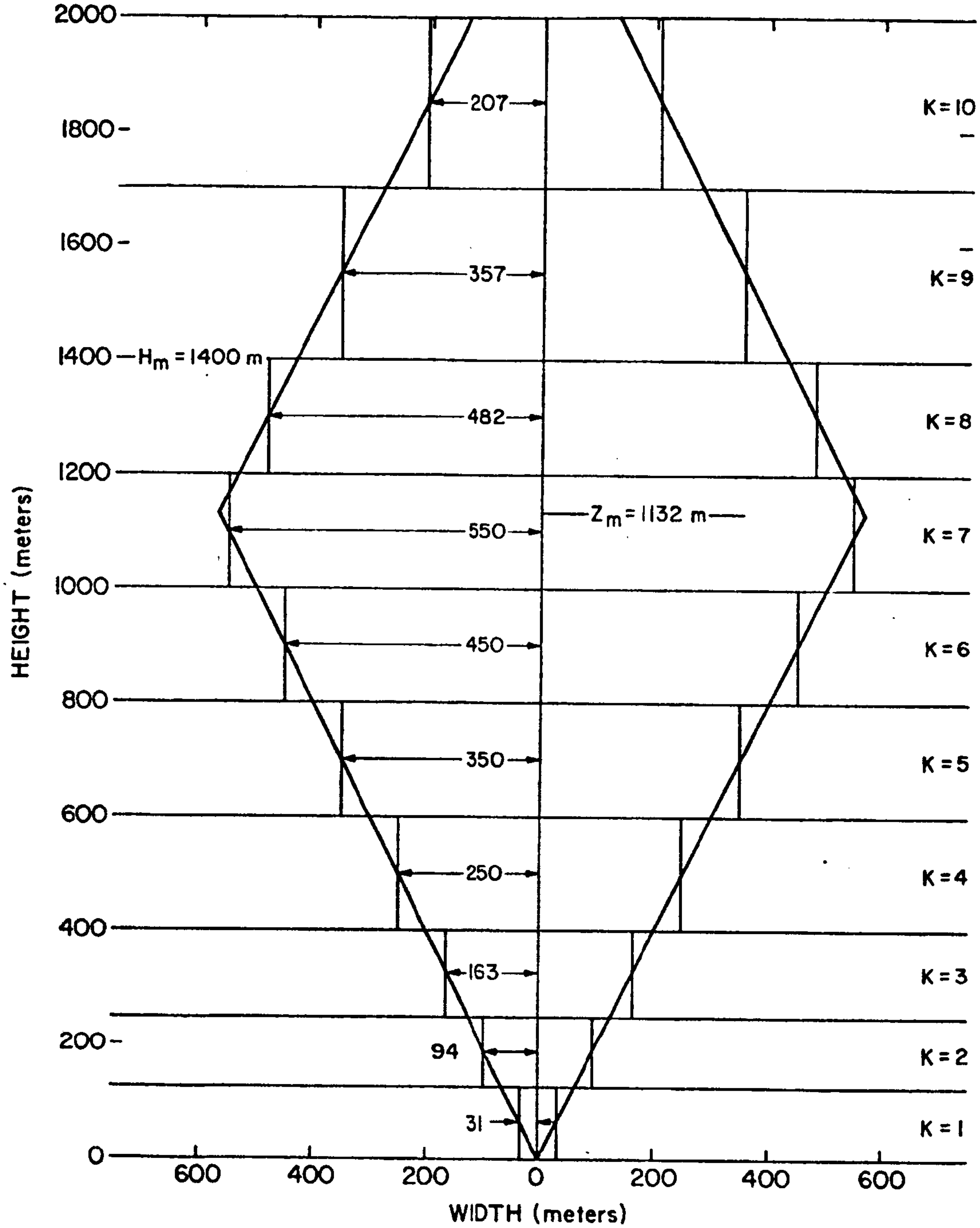

FIGURE 6-19. Dimensions of the stabilized cloud of exhaust products for use with Model 4 calculated for the post-cold front meteorological regime at KSC and the on-pad abort of a Titan III C vehicle. Height of the cloud centroid is 1132 meters and the surface mixing layer depth is 1400 meters.

stabilized cloud dimensions for use in Model 3, calculated from Equations (6-12) and (6-13), are shown in Figure 6-20. The source model inputs, including the vertical distribution of material calculated according to the procedures outlined in Section 6.2.1, are given in Table E-5 of Appendix E for Model 4 and in Table E-6 for application of Model 3.

Results of the Calculations

Results of the concentration and dosage calculations for the on-pad abort of a Titan III C vehicle during a post-cold front meteorological regime at KSC are presented in Figures 6-21 and 6-22. In both figures, the results obtained by applying Model 3 are given by the dashed curve and those obtained by applying Model 4 by the solid curves. Figure 6-21 shows maximum centerline concentrations χ_c at ground level, calculated using both models, at distances beyond 10 kilometers downwind from the point of cloud stabilization. At these distances, there is essentially no difference in the results obtained by using either Model 3 or Model 4. Average alongwind centerline concentration and 10-minute time mean centerline concentrations calculated using Model 4 are also shown in Figure 6-21. Dosages downwind from the on-pad abort calculated using Models 3 and 4 are shown in Figure 6-22.

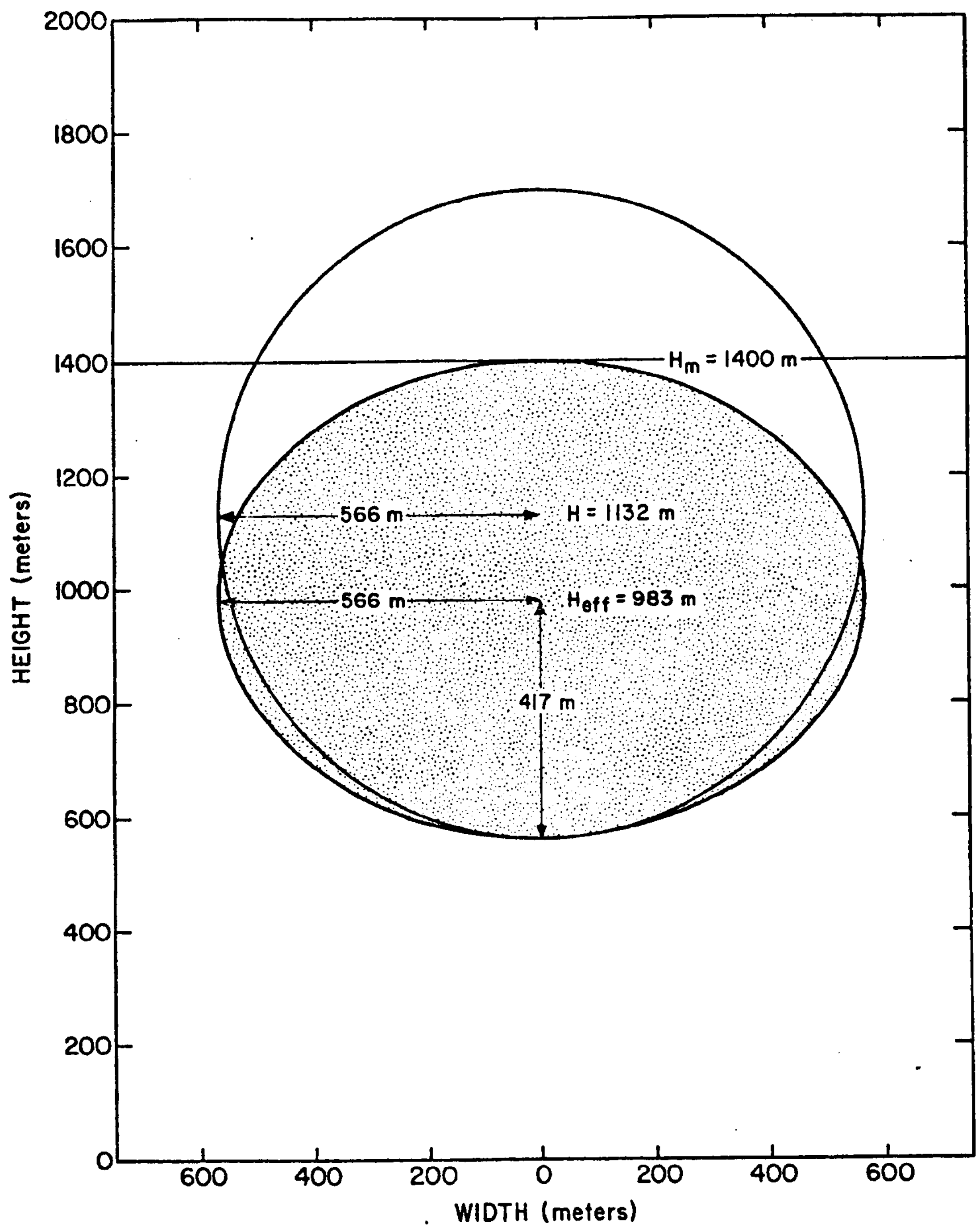

FIGURE 6-20. Dimensions of the stabilized cloud of exhaust products for use with Model 3 calculated for the post-cold front meteorological regime at Kennedy Space Center and the on-pad abort of a Titan III C vehicle. The effective height of the cloud in the surface layer is 983 meters.

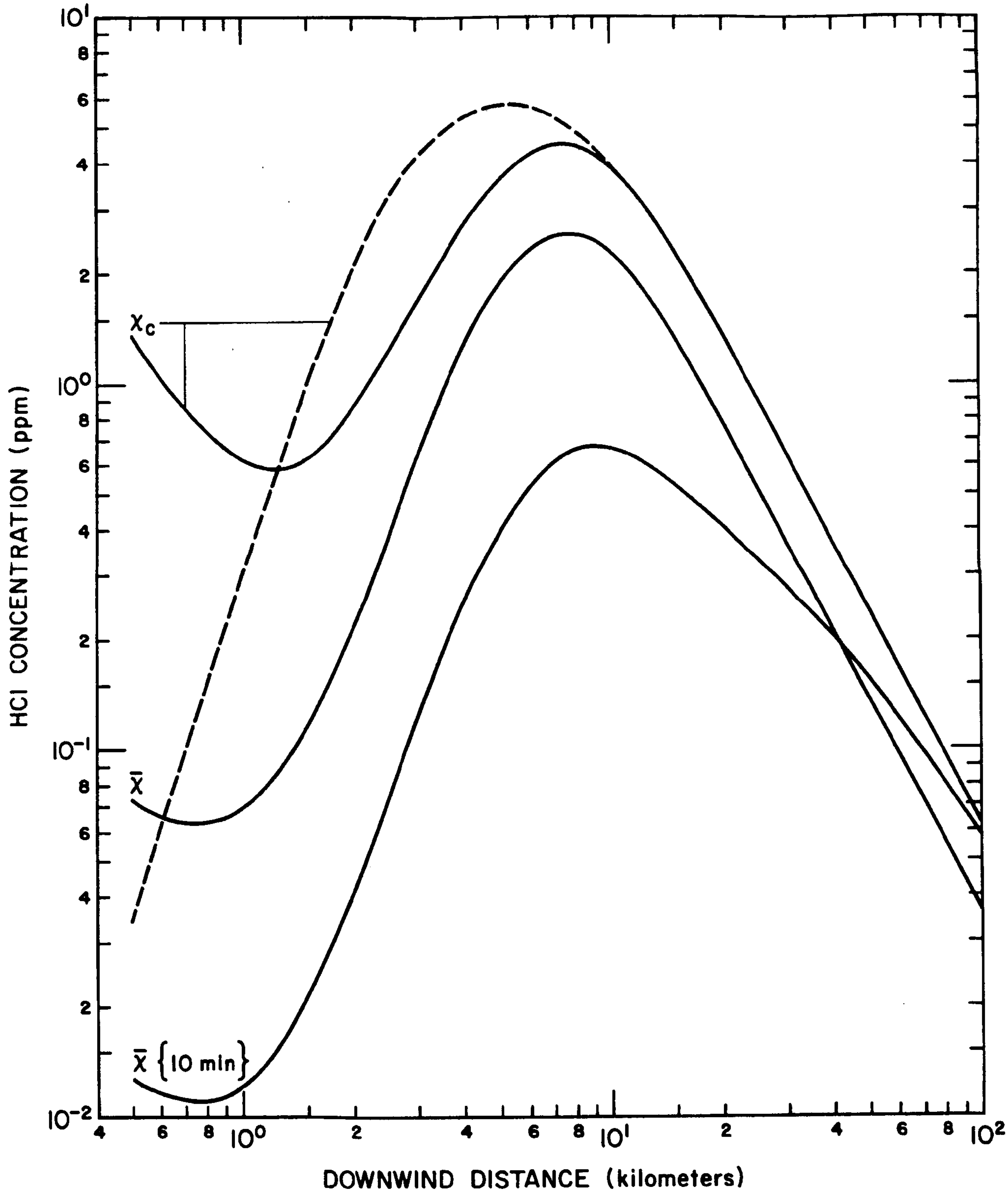

FIGURE 6-21. Maximum centerline, average alongwind and ten-minute time mean alongwind concentrations at ground level for an on-pad abort during a post-cold front meteorological regime at KSC. The dashed profile for maximum centerline concentration was calculated using Model 3 and the remaining profiles were calculated using Model 4.

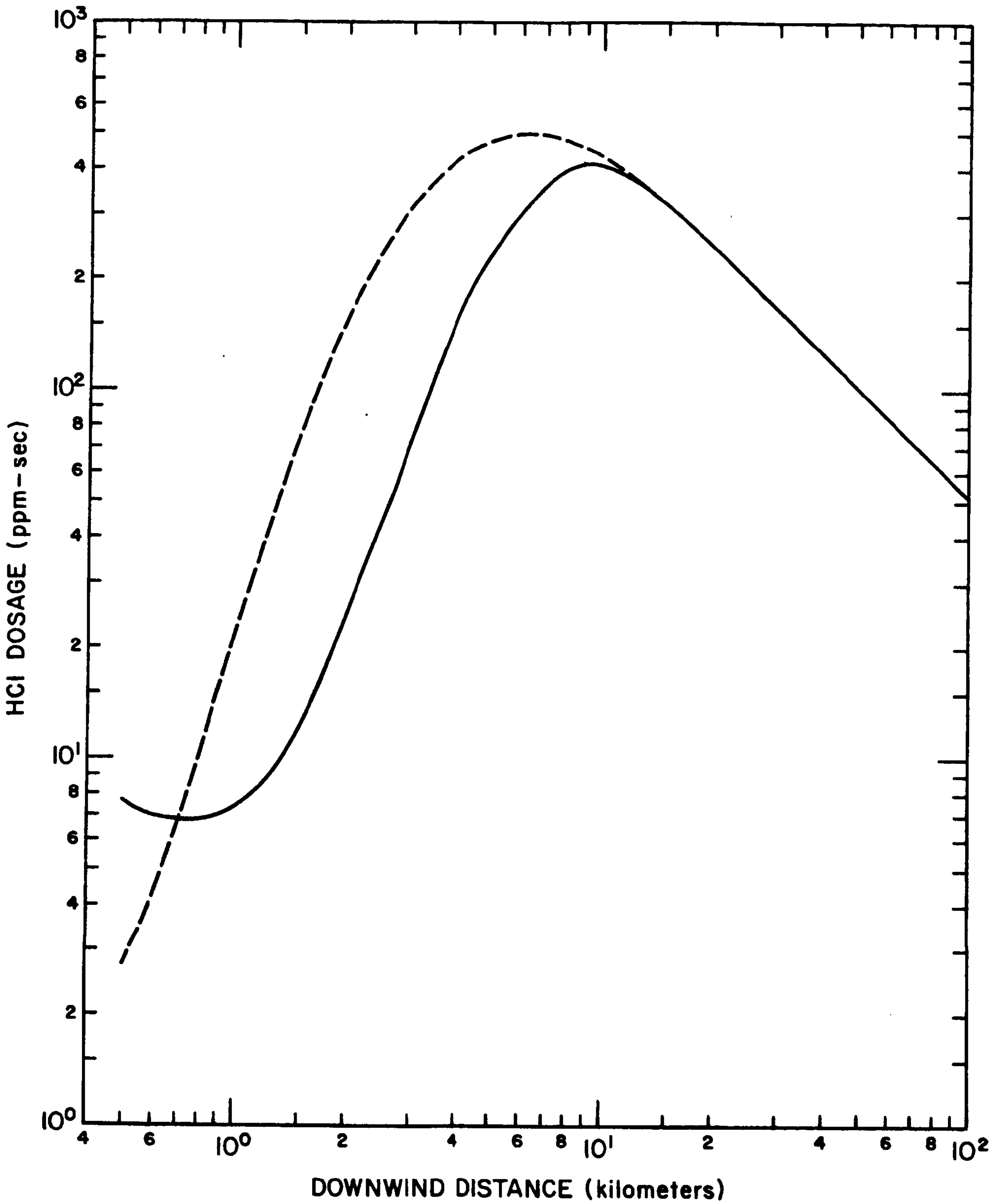

FIGURE 6-22. Maximum centerline dosage at ground level downwind from the point of cloud stabilization for an on-pad abort during a post-cold front meteorological regime at KSC. The dashed profile was calculated using Model 3 and the solid profile was calculated using Model 4.

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APPENDIX A

DERIVATION OF MAXIMUM CLOUD RISE FORMULAS FOR INSTANTANEOUS AND CONTINUOUS SOURCES

Derivations are presented below of the formulas given in Section 3 for the maximum buoyant cloud rise from instantaneous and continuous sources. These derivations are based principally on material contained in a preprint of a paper by G. A. Briggs (1970) presented at the Second International Clean Air Congress.

A.1 INSTANTANEOUS CLOUD RISE FORMULAS

The derivations of the cloud rise formulas for instantaneous sources assume that the cloud has a horizontal component of motion nearly equal to the mean wind speed $\bar{u}$ and nearly the same density ρ as the ambient air. For a cloud of radius r, the mass is then approximately $4/3\ \pi\, r^3 \rho$. The vertical momentum is $w(4/3\ \pi\, r^3 \rho)$, where w is the vertical velocity of the cloud center moving downwind at a speed $\bar{u}$ so that

$$w = \bar{u}\, dz/dx = dz/dt \qquad \text{(A-1)}$$

where x is the downwind distance from the point of release. The initial momentum divided by $4/3\ \pi\, \rho$ is defined by

$$F_m = w_o\, r_o^3 = \text{constant} \qquad \text{(A-2)}$$

where w_o is the initial vertical velocity imparted to the cloud over an effective radius r_o. Setting the time rate of change of vertical momentum equal to the buoyancy, we obtain the expression

$$d\left(w\, r^3\right)/dt = \bar{u}\, d\left(w\, r^3\right)/dx = b\, r^3 \qquad \text{(A-3)}$$

where

b = the buoyant acceleration of the cloud $g(\rho - \rho_c)/\rho$

g = the acceleration due to gravity

ρ_c = the density of the cloud

ρ = the density of the ambient air

The initial value of $b\,r^3$ is defined by the expression

$$F_I = b\,r_o^3 \approx \frac{3g\,Q_I}{4\,c_p\,\pi\,\rho\,T} = \text{constant} \qquad \text{(A-4)}$$

where

Q_I = heat released (cal)

c_p = specific heat of air at constant pressure (cal $g^{-1}\,{}^oK^{-1}$)

T = ambient air temperature (${}^oK$)

A.1.1 Instantaneous Cloud Rise Formula for an Adiabatic Atmosphere

For an adiabatic atmosphere (potential temperature constant with height), the total buoyancy of the cloud is conserved and Equation (A-3) becomes

$$d(w\,r^3)/dt = \bar{u}\,d(w\,r^3)/dx = b\,r_o^3 = F_I \qquad \text{(A-5)}$$

Integration of Equation (A-5) with respect to x yields

$$w\,r^3 = F_I\,x/\bar{u} + F_m \qquad \text{(A-6)}$$

where the constant F_m results from Equation (A-2) and the boundary condition $x = 0$ at $t = 0$. Experimental evidence (Briggs, 1970) indicates a linear dependence of r with height which may be generalized to the form

$$r = \gamma_I z + r_R \tag{A-7}$$

where

γ_I = the entrainment coefficient for an instantaneous source

r_R = the reference cloud radius at the source when the initial cloud dimension is large

z = the height above the source

Substitution of Equations (A-1) and (A-7) into Equation (A-6) gives

$$\bar{u}\left(\gamma_I z + r_R\right)^3 dz = F_I \frac{x}{\bar{u}} dx + F_m dx \tag{A-8}$$

which may be integrated to give

$$\frac{\bar{u}}{4\gamma_I}\left(\gamma_I z + r_R\right)^4 = \frac{F_I}{2\bar{u}} x^2 + F_m x + C \tag{A-9}$$

The boundary condition that $x = z = 0$ at $t = 0$ defines C as $\bar{u}\, r_R^4 / 4\gamma_I$. Equation (A-9) may then be solved for z to give the cloud rise as

$$z = \left[\frac{2F_I}{\bar{u}^2 \gamma_I^3} x^2 + \frac{4F_m}{\bar{u}\gamma_I^3} x + \left(\frac{r_R}{\gamma_I}\right)^4\right]^{1/4} - \frac{r_R}{\gamma_I} \tag{A-10}$$

In general, the momentum term F_m is negligible in comparison with the buoyancy term F_I. The maximum buoyant rise of an instantaneous cloud in an adiabatic atmosphere is then given by

$$z_{mI} = \left[\frac{2F_I t_{sI}^2}{\gamma_I^3} + \left(\frac{r_R}{\gamma_I}\right)^4\right]^{1/4} - \frac{r_R}{\gamma_I} \tag{A-11}$$

where $x = \bar{u}t$ and t_{sI} is the time in seconds required for the cloud to achieve stabilization in an adiabatic atmosphere. Limited experimental evidence indicates that t_{sI} is a constant for each launch vehicle, ranging from about 180 to 380 seconds.

A.1.2 Instantaneous Cloud Rise Formula for a Stable Atmosphere

If heat is conserved as the cloud rises adiabatically in a stable environment, the rate at which each cloud element loses temperature relative to the ambient air entrained into the cloud as it rises is given by the product of the ambient potential temperature gradient and the rate of rise. The resulting decay of buoyancy is given by the expression

$$d(b\, r^3)/dt = \bar{u}\, d(b\, r^3)/dx = -w\, s\, r^3 \tag{A-12}$$

where

$$s = \frac{g}{T}\frac{\partial \Phi}{\partial z} \approx \frac{g}{T}\frac{\Delta \Phi}{\Delta z} \tag{A-13}$$

$\frac{\Delta \Phi}{\Delta z}$ = vertical gradient of ambient potential temperature

Differentiating the central term of Equation (A-3) with respect to time, we obtain

$$d^2(w\, r^3)/dt^2 = \frac{d}{dt}\left[\bar{u}\, d(w\, r^3)/dx\right]$$

$$= \bar{u}\frac{d}{dx}\left[d(w\, r^3)/dt\right]$$

and, since $x = \bar{u}\, t$,

$$\begin{aligned} d^2(w\, r^3)/dt^2 &= \bar{u}\frac{d}{dx}\left[\bar{u}\, d(w\, r^3)/dx\right] \\ &= \bar{u}^2\left[d^2\,(w\, r^3)/dx^2\right] \end{aligned} \tag{A-14}$$

Also, by differentiating the right-hand term of Equation (A-3) with respect to time, we obtain

$$
\begin{aligned}
d^2(w\ r^3)/dt^2 &= d(b\ r^3)/dt \\
&= \bar{u}\ d(b\ r^3)/dx
\end{aligned}
\qquad \text{(A-15)}
$$

Thus, equating Equations (A-14) and (A-15), we obtain

$$\bar{u}^2\ d^2(w\ r^3)/dx^2 = \bar{u}\ d(b\ r^3)/dx \qquad \text{(A-16)}$$

After substituting Equation (A-12) into Equation (A-16), the result is

$$\bar{u}^2\ d^2(w\ r^3)/dx^2 = -\ s(w\ r^3) \qquad \text{(A-17)}$$

If s is positive and approximately constant with height, the momentum can be expressed as the harmonic function

$$w\ r^3 = A \cos\left(s^{1/2}\ \frac{x}{\bar{u}}\right) + B \sin\left(s^{1/2}\ \frac{x}{\bar{u}}\right) \qquad \text{(A-18)}$$

where A and B are constants to be determined. Thus,

$$d(w\ r^3)/dx = -\frac{A\ s^{1/2}}{\bar{u}} \sin\left(s^{1/2} \frac{x}{\bar{u}}\right) + \frac{B\ s^{1/2}}{\bar{u}} \cos\left(s^{1/2}\ \frac{x}{\bar{u}}\right) \qquad \text{(A-19)}$$

and from Equation (A-3)

$$\frac{d(w\ r^3)}{dx} = \frac{b\ r^3}{\bar{u}} \qquad \text{(A-20)}$$

Also,

$$\frac{d^2(w\ r^3)}{dx^2} = \frac{-As}{\bar{u}^2} \cos\left(s^{1/2} \frac{x}{\bar{u}}\right) - \frac{Bs}{\bar{u}^2} \sin\left(s^{1/2} \frac{x}{\bar{u}}\right) \qquad \text{(A-21)}$$

and, from Equation (A-17),

$$\frac{d^2(w\,r^3)}{dx^2} = -\frac{s}{\bar{u}^2}(w\,r^3) \qquad \text{(A-22)}$$

From Equations (A-2), (A-21) and (A-22), at time $t = 0$ and distance $x = 0$, the value of A is

$$A = (w\,r^3)\Big|_{t=0} = w_o\,r_o^3 = F_m$$

Similarly, the value of B from Equations (A-3), (A-4), (A-19) and (A-20) is

$$\frac{B\,s^{1/2}}{\bar{u}} = \frac{b\,r^3}{\bar{u}}\Bigg|_{t=0}$$

$$B = \frac{b\,r_o^3}{s^{1/2}} = \frac{F_I}{s^{1/2}}$$

Equation (A-18) can then be rewritten in the form

$$w\,r^3 = F_m \cos\left(s^{1/2}\frac{x}{\bar{u}}\right) + \frac{F_I}{s^{1/2}} \sin\left(s^{1/2}\frac{x}{\bar{u}}\right) \qquad \text{(A-23)}$$

If we assume the cloud radius to be defined by Equation (A-7) and substitute this relationship in Equation (A-23), the result is

$$w\left(r_R + \gamma_I z\right)^3 = F_m \cos\left(s^{1/2}\frac{x}{\bar{u}}\right) + \frac{F_I}{s^{1/2}} \sin\left(s^{1/2}\frac{x}{\bar{u}}\right) \qquad \text{(A-24)}$$

Substituting $w = \bar{u}\;dz/dx$,

$$\bar{u}\left(r_R + \gamma_I z\right)^3 \, dz = F_m \cos\left(s^{1/2} \frac{x}{\bar{u}}\right) dx + \frac{F_I}{s^{1/2}} \sin\left(s^{1/2} \frac{x}{\bar{u}}\right) \tag{A-25}$$

Integrating Equation (A-25), we obtain

$$\frac{\bar{u}\left(r_R + \gamma_I z\right)^4}{4\gamma_I} = \frac{F_m \bar{u}}{s^{1/2}} \sin\left(s^{1/2} \frac{x}{\bar{u}}\right) - \frac{F_I \bar{u}}{s} \cos\left(s^{1/2} \frac{x}{\bar{u}}\right) + C \tag{A-26}$$

or

$$z = \left[\frac{4F_m}{\gamma_I^3 s^{1/2}} \sin\left(s^{1/2} \frac{x}{\bar{u}}\right) - \frac{4F_I}{\gamma_I^3 s} \cos\left(s^{1/2} \frac{x}{\bar{u}}\right) + C'\right]^{1/4} - \frac{r_R}{\gamma_I} \tag{A-27}$$

Evaluating C' at t = 0 gives

$$C' = \frac{4F_I}{\gamma_I^3 s} + \left(\frac{r_R}{\gamma_I}\right)^4 \tag{A-28}$$

Rewriting Equation (A-27) with C' given by Equation (A-28) and $x = \bar{u}\, t$ gives

$$z = \left[\frac{4F_m}{\gamma_I^3 s^{1/2}} \sin\left(s^{1/2} t\right) + \frac{4F_I}{\gamma_I^3 s}\left(1 - \cos\left(s^{1/2} t\right)\right) + \left(\frac{r_R}{\gamma_I}\right)^4\right]^{1/4} - \frac{r_R}{\gamma_I} \tag{A-29}$$

The maximum buoyant cloud rise in a stable atmosphere z_{mI}, where F_m is negligible when compared with F_I, occurs at $t = \pi/s^{1/2}$. The resulting expression is

$$z_{mI} = \left[\frac{8F_I}{\gamma_I^3 s} + \left(\frac{r_R}{\gamma_I}\right)^4\right]^{1/4} - \frac{r_R}{\gamma_I} \tag{A-30}$$

A.2 CONTINUOUS CLOUD RISE FORMULAS

The derivations of the buoyant cloud rise formulas for continuous sources also assume that the cloud density ρ is nearly the same as the density of the ambient air and that the horizontal component of cloud motion is approximately equal to the mean wind speed $\bar{u}$. The buoyancy flux (divided by $\pi\rho$) is given by the time derivative of the vertical momentum flux (divided by $\pi\rho$)

$$d(w\,\bar{u}\,r^2)/dt = \bar{u}\,d(w\,\bar{u}\,r^2)/dx = b\,\bar{u}\,r^2 \tag{A-31}$$

The terms and form of Equation (A-31) are analogous to Equation (A-3), except that we are now considering a flux of both buoyancy and momentum. The initial momentum flux divided by $\pi\rho$ is defined by

$$F_m = (w\,\bar{u}\,r^2)_{t=0} = w_o^2\,r_o^2 \tag{A-32}$$

where w_o is the initial vertical velocity imparted to the cloud over an effective radius r_o. The initial value of the buoyancy flux (divided by $\pi\rho$) $b\,\bar{u}\,r^2$ is approximately defined by the expression

$$F_c = (b\,\bar{u}\,r^2)_{t=0} = b\,w_o\,r_o^2 \approx \frac{g\,Q_c}{\pi\,\rho\,c_p\,T} \tag{A-33}$$

where Q_c is the effective rate of heat release in calories per second, and the other terms are defined in the same manner as those of Equation (A-4).

A.2.1 Continuous Cloud Rise Formula for an Adiabatic Atmosphere

For an adiabatic atmosphere, the buoyancy flux is conserved, and Equation (A-31) becomes

$$d(w\,\bar{u}\,r^2)/dt \;=\; \bar{u}\,d(w\,\bar{u}\,r^2)/dx \;=\; b\,w_o\,r_o^2 \;=\; F_c \tag{A-34}$$

Integration of Equation (A-34) with respect to x yields

$$w\,\bar{u}^2\,r^2 \;=\; F_c\,x \;+\; F_m\,w_o \tag{A-35}$$

where the constant $F_m\,w_o$ is determined by Equation (A-32) and the boundary condition that $x = 0$ at $t = 0$. Substitution of Equations (A-1) and (A-7) into Equation (A-35) gives

$$\bar{u}^3\,(\gamma_c\,z + r_R)^2\,dz \;=\; F_c\,x\,dx \;+\; F_m\,w_o\,d_x \tag{A-36}$$

where γ_c is the entrainment coefficient for a continuous source. Equation (A-36) may be integrated to find that

$$\frac{\bar{u}^3}{3\,\gamma_c}\,(\gamma_c\,z + r_R)^3 \;=\; \frac{F_c}{2}\,x^2 \;+\; F_m\,w_o\,x \;+\; C \tag{A-37}$$

Since x and z are zero at $t = 0$, the constant C is equal to $(\bar{u}\,r_R)^3/3\gamma_c$. Equation (A-37) may then be solved for z to give the cloud rise

$$z \;=\; \left[\frac{3\,F_c}{2\,\gamma_c^2\,\bar{u}^3}\,x^2 \;+\; \frac{2\,F_m\,w_o}{\gamma_c^2\,\bar{u}^3}\,x \;+\; \left(\frac{r_R}{\gamma_c}\right)^3\right]^{1/3} \;-\; \frac{r_R}{\gamma_c} \tag{A-38}$$

For buoyancy-dominated rise, the momentum term may be neglected, and the maximum buoyant rise for a continuous source is given by

$$z_{mc} = \left[\frac{3 F_c x_{sc}^2}{2 \gamma_c^2 \bar{u}^3} + \left(\frac{r_R}{\gamma_c} \right)^3 \right]^{1/3} - \frac{r_R}{\gamma_c} \tag{A-39}$$

where x_{sc} is the downwind distance in meters required for the cloud to reach stabilization. The value of x_{sc} is dependent on vehicle type, atmospheric stability, and the wind speed. For large vehicles, x_{sc} is 1 to 2 kilometers.

A.2.2 Continuous Cloud Rise Formula for a Stable Atmosphere

In analogy to Equation (A-12), the decay of the buoyancy flux (divided by $\pi \rho$) with time in a stable atmosphere is given by

$$d(b \bar{u} r^2)/dt = \bar{u}\, d(b \bar{u} r^2)/dx = - w s \bar{u} r^2 \tag{A-40}$$

where the terms are defined in the same manner as those of Equation (A-12). Differentiating Equation (A-31) with respect to time, assuming $x = \bar{u} t$, and substituting Equation (A-40) leads to the expression

$$\bar{u}^2 \frac{d^2 (w \bar{u} r^2)}{dx^2} = - s(w \bar{u} r^2) \tag{A-41}$$

If the quantity s is approximately constant with height, Equation (A-41) indicates that the vertical momentum flux (divided by $\pi \rho$) can be expressed by the harmonic function

$$(w \bar{u} r^2) = F_m \cos\left(s^{1/2} \frac{x}{\bar{u}}\right) + \frac{F_c}{s^{1/2}} \sin\left(s^{1/2} \frac{x}{\bar{u}}\right) \tag{A-42}$$

where the constants F_m and F_c are determined from Equations (A-32) and (A-33) and the boundary condition that $x = 0$ at $t = 0$.

Substitution of Equations (A-1) and (A-7) into Equation (A-42) yields

$$\bar{u}^2 (\gamma_c z + r_R)^2 dz = F_m \cos\left(s^{1/2} \frac{x}{\bar{u}}\right) dx + \frac{F_c}{s^{1/2}} \sin\left(s^{1/2} \frac{x}{\bar{u}}\right) dx \qquad \text{(A-43)}$$

where γ_c is the entrainment coefficient for a continuous source. Integrating Equation (A-43) and solving for z with the boundary condition that $z = 0$ when $x = t = 0$ gives

$$z = \left[\frac{3 F_m}{\gamma_c^2 \bar{u} s^{1/2}} \sin\left(s^{1/2} t\right) + \frac{3 F_c}{\bar{u} \gamma_c^2 s}\left(1 - \cos\left(s^{1/2} t\right)\right) + \left(\frac{r_R}{\gamma_c}\right)^3\right]^{1/3} - \frac{r_R}{\gamma_c} \qquad \text{(A-44)}$$

For buoyancy dominated rise, the buoyant cloud rise is given by

$$z = \left[\frac{3 F_c}{\bar{u} \gamma_c^2 s}\left(1 - \cos\left(s^{1/2} t\right)\right) + \left(\frac{r_R}{\gamma_c}\right)^3\right]^{1/3} - \frac{r_R}{\gamma_c} \qquad \text{(A-45)}$$

The maximum rise of the continuous cloud in a stable atmosphere occurs at $t = \pi/s^{1/2}$ and is given by

$$z_{mc} = \left[\frac{6 F_c}{\bar{u} \gamma_c^2 s} + \left(\frac{r_R}{\gamma_c}\right)^3\right]^{1/3} - \frac{r_R}{\gamma_c} \qquad \text{(A-46)}$$

APPENDIX B

USER INSTRUCTIONS FOR THE NASA/MSFC MULTILAYER DIFFUSION MODEL COMPUTER PROGRAM

B.1 PROGRAM DESCRIPTION

The NASA/MSFC Multilayer Diffusion Model Program is constructed using 16 subroutines, including the main driver program. The program is written in the FORTRAN V language and is designed for execution on a UNIVAC 1108 computer. The program requires 29436_{10} words of executable core storage on the UNIVAC 1108 including necessary Fortran library and system programs. The multilayer program uses 16707_{10} locations for program variable storage with the remainder of storage used for machine instructions. The program consists of five main logic sections which provide different types of calculations and program output. A block diagram of these logic sections is given in Figure 5-1 in the main body of the report and a diagram of the program linkage is given in Section B.6. The subroutine linkage of each logic section is shown in Section B.7. Program assembly time is approximately 26 seconds and the average execution time is 0.01 seconds per calculation grid point.

B.1.1 Logic Section 1

Logic Section 1 calculates fields of dosage, concentration, time-mean alongwind concentration, and average alongwind concentration on a three-dimensional reference polar coordinate grid system. The orientation of the grid fixes north at 0 degrees and east at 90 degrees. The vertical coordinates are provided by the layer structure with optional heights within the layers. Options in this section include the calculation of dosage and concentration with cloud depletion by precipitation scavenging, deposition on the ground due to precipitation scavenging and simple time-dependent decay. Models 1 through 5 are used in Logic Section 1. This section uses subroutines READER, WASHT, TESTR, BREAK, ISØ, PEAK, EL, LATER, VERT, SIGMA, CØØRD, as well as the main driver program.

Subroutine READER reads and converts all of the program input data. All program input instructions reference logical tape 5 (card reader) and all output instructions reference logical tape 6 (printer). Model equations included in this subroutine are (4-2), (4-3), (4-5), (4-6), (4-17), (4-19), (4-20), (4-23), (4-24), (4-27) and (4-28) given in Section 4 of the main body of this report.

Subroutine WASHT calculates ground-level patterns of deposition due to precipitation scavenging using Model 5 (Equations (4-34) and (4-35)).

Subroutine TESTR defines the new layer structure for layer step-change Model 4.

Subroutine BREAK is the main calculation routine for Logic Section 1 and includes Models 1 through 5. Equations used in this subroutine include the peak terms of (4-1), (4-7), (4-15), (4-18), (4-29) and part of the error function of (4-18).

Subroutine ISØ evaluates the error function, Equation (4-18), used in the calculations of Model 4.

Subroutine PEAK calculates the peak terms for dosage and concentration in Models 1, 2 and 3 using Equations (4-1), (4-7) and (4-15).

Subroutine ACH has entry points EL and LATER. EL evaluates the term $L\{x_K\}$ as given by Equation (4-9) and LATER evaluates the crosswind terms in y used in Equations (4-1) and (4-15).

Subroutine VERT calculates the vertical and vertical reflection terms for Model 3 as given by Equation (4-15).

Subroutine SIGMA calculates the various standard deviations for the dosage and concentration distributions as given by Equations (4-4), (4-8), (4-13), (4-14), (4-16) and (4-22).

Subroutine CØØRD performs all coordinate transformations. The layer models are written with reference to a cloud or plume coordinate system where the x-axis is oriented along the mean wind direction from the source, the y-axis is perpendicular to the x-axis in the crosswind direction, and the z-axis is directed vertically. The subroutine relates the cloud coordinate system which is relative to a source location to the fixed reference coordinate system.

B.1.2 Logic Section 2

Logic Section 2 calculates centerline dosage and maximum centerline concentration along the downwind cloud axis relative to the source location for Models 1, 2 and 3. Options include the calculation of dosage and concentration in the presence of cloud depletion by precipitation scavenging or simple time dependent decay. This section uses subroutines CENTRL, EL, PEAK, VERT and SIGMA, as well as the main driver program.

Subroutine CENTRL performs the main calculations and controls all output. All other subroutines used in this section have the same function as described above.

B.1.3 Logic Section 3

Logic Section 3 calculates isopleths of dosage and/or concentration in the horizontal plane, about the cloud alongwind axis, using Models 1, 2 and 3. Options include the calculation of dosage and concentration isopleths with cloud depletion by precipitation scavenging or simple time-dependent decay. This section uses subroutines ISOXY, EL, PEAK, VERT, and SIGMA, as well as the main driver program.

Subroutine ISØXY performs the main calculations for Logic Section 3 and controls all output.

B.1.4 Logic Section 4

Logic Section 4 calculates isopleths of dosage and concentration in the vertical plane about the alongwind cloud axis at selected downwind distances for Models 1, 2 and/or 3. Options include calculations of dosage and concentration isopleths with cloud depletion by precipitation scavenging and simple time-dependent decay. This section uses subroutines ISØYZ, EL, PEAK, VERT, and SIGMA, as well as the main driver program.

Subroutine ISOYZ performs the main calculations for Logic Section 4 and controls all output. The functions of all other subroutines in this section have been described above.

B.1.5 Logic Section 5

Logic Section 5 of the program calculates deposition on the ground due to gravitational settling using Model Equations (4-36) through (4-51). This section uses subroutines DEPØS, SGP, CØØRD, as well as the main driver program.

Subroutine DEPØS controls the logic for calculating the deposition and outputs all calculations.

Subroutine SGP consists of the entry points SGP, UBARS, DEPSØ and BETAK, where SGP evaluates Equations (4-41), (4-42) and (4-46); UBARS evaluates Equations (4-39) and (4-40); DEPSØ evaluates Equations (4-37) and (4-38); and BETAK evaluates Equations (4-43), (4-44) and (4-47).

B.2 PROGRAM INPUT PARAMETERS

The data input parameters required for the computer program are listed in Table B-1. The information categories in the table are defined as follows:

TABLE B-1

DATA INPUT INFORMATION

NAMELIST	FORTRAN	Model	Units	Limits	Value (3)	Array Size (7)	Logic Section
NAM1	DATE	N/A	N/A	N/A	Blanks	2	N/A
	NP	N/A	N/A	≥ 0	N/A	1	N/A
NAM2	TESTNØ	N/A	N/A	N/A	Blanks	12	1, 2, 3, 4, 5
	ISKIP	N/A	N/A	(1)	0	30	1, 2, 3, 4, 5
	NXS	N/A	N/A	≤ 100	34	1	1, 5
	NYS	N/A	N/A	≤ 100	(9)	1	1, 5
	NZS	N/A	N/A	≤ 21	0	1	1, 2, 3, 4, 5
	NDI	N/A	N/A	≤ 10	0	1	3, 4
	NCI	N/A	N/A	≤ 10	0	1	3, 4
	NDXR	N/A	N/A	≤ 100	34	1	2, 3, 4
	NBK	N/A	N/A	≤ 10	0	1	1
	NPTS	N/A	N/A	≤ 100	NZS - 1	1	1, 2, 3, 4
	NVS	N/A	N/A	≤ 20	0	1	5
	NVB	N/A	N/A	≤ 20	0	1	5
	XX	x	Meters	> 0.0	(10)	100	1, 5
	YY	y	Degrees	$0.0 \leq y \leq 360.0$	(11)	100	1, 5

TABLE B-1 (Continued)

NAMELIST	FORTRAN	Model	Units	Limits	Value (3)	Array Size (7)	Logic Section
NAM2	Z	z_{B1} and z_{TK}	Meters	≥ 2.0	$z(1) = 2.0$	21	1, 2, 3, 4, 5
	DXR	x	Meters	> 0.0	(10)	100	2, 3, 4
	DELX	Δx	Meters	≥ 0.0	0.0	20	1, 5
	DELY	Δy	Degrees	$0.0 \leq \Delta y \leq 360.0$	0.0	20	1, 5
	Q	Q	(2)	≥ 0.0	0.0	20	1, 2, 3, 4, 5
	UBARK	$\bar{u}_R$ and $\bar{u}_{TK}$	Meters Sec^{-1}	≥ 0.1	0.1	21	1, 2, 3, 4, 5
	SIGAK	$\sigma_{AR}\{\tau_{oK}\}$ & $\sigma_{ATK}\{\tau_{oK}\}$	Degrees	≥ 0.5	0.5	21	1, 2, 3, 4, 5
	SIGEK	σ_{ER} & σ_{ETK}	Degrees	≥ 0.1	0.1	21	1, 2, 3, 4, 5
	SIGXØ	$\sigma_{xo}\{K\}$	Meters	> 0.0	N/A	20	1, 2, 3, 4, 5
	SIGYØ	$\sigma_{yo}\{K\}$	Meters	> 0.0	N/A	20	1, 2, 3, 4, 5
	SIGZØ	$\sigma_{zo}\{K\}$	Meters	≥ 0.0	$\frac{z\{K+1\} - z\{K\}}{\sqrt{12}}$	20	1, 2, 3, 4, 5
	ALPHA	α_K	N/A	≥ 0.0	1.0	20	1, 2, 3, 4, 5
	BETA	β_K	N/A	≥ 0.0	1.0	20	1, 2, 3, 4, 5
	ZRK	z_R	Meters	$\geq z(1)$	2.0	1	1, 2, 3, 4, 5
	TIMAV	T_A	Seconds	≥ 0.0	600.0	1	1
	THETAK	θ_{B1} & θ_{TK}	Degrees	$0.0 \leq \theta_K \leq 360.0$	0.0	21	1, 2, 3, 4, 5

TABLE B-1 (Continued)

NAMELIST	FORTRAN	Model	Units	Limits	Value (3)	Array Size (7)	Logic Section
NAM2	TAUK	τ_K	Seconds	> 0.0	N/A	1	1, 2, 3, 4, 5
	TAUØK	τ_{oK}	Seconds	≥ 0.0	600.0	1	1, 2, 3, 4, 5
	H	H_K	Meters	≥ 0.0	0.0	20	1, 2, 3, 4, 5
	XRY	x_{ry}	Meters	≥ 0.0	100.0	1	1, 2, 3, 4, 5
	XRZ	x_{rz}	Meters	≥ 0.0	100.0	1	1, 2, 3, 4, 5
	XLRY	x_{Ry}	Meters	≥ 0.0	0.0	1	1, 2, 3, 4, 5
	XLRZ	x_{Rz}	Meters	≥ 0.0	0.0	1	1, 2, 3, 4, 5
	ZZL	z	Meters	≥ 2.0	z	1	1, 2, 3, 4
	IZMØD	N/A	N/A	= 0, 1, 2 or 3	1	20	1, 2, 3, 4
	DECAY	k	Seconds^{-1}	≥ 0.0	0.0	1	1, 2, 3, 4
	ZLIM	z_{lim}	Meters	$= z_{TK}$	(5)	1	1, 2, 3, 4
	TIM1	t_1	Seconds	> 0.0	(5)	1	1, 2, 3, 4
	BLAMDA	Λ	Seconds^{-1}	> 0.0	(5)	1	1, 2, 3, 4
	IFLAG	N/A	N/A	= 0 or 1	0	100	4
	DI	$D_K\{x_K, y_K, K\}$	Grams Seconds^{-1} Meters (4)	> 0.0	(5)	10	3, 4
	CI	$\chi_K\{x_K, y_K, t_K\}$	Grams Meters^{-3} (4)	> 0.0	(5)	10	3, 4
	TAST	t*	Seconds	≥ 0.0	1.0	10	1

TABLE B-1 (Continued)

NAMELIST	FORTRAN	Model	Units	Limits	Value (3)	Array Size (7)	Logic Section
NAM2	JBØT	N/A	N/A	N/A	(5)	10	1
	JTØP	N/A	N/A	N/A	(5)	10	1
	VS	V_s	Meters Sec^{-1}	>0.0	(5)	20	5
	PERC	f_i	N/A	>0.0	(5)	20	5
	ACCUR	R	N/A	(6)	(5)	20	5
	VB	V_{SK}	Meters Sec^{-1}	>0.0	(5)	20	5
	PERCB	f_i	N/A	>0.0	(5)	20	5
	HB	H_{SK}	Meters	≥ 0.0	0.0	1	5
	T	T_K	Seconds	>0.0	(5)	20	5
	DELPHI	$\Delta\phi$	Degrees	≥ 0.0	180.0	1	1, 5
NAM3 (8)	ALPHL	α_L	N/A	≥ 0.0	ALPHA(JBØT & JTØP)	10	1
	BETL	β_L	N/A	≥ 0.0	BETA(JBØT & JTØP)	10	1
	TAUL	τ_L	Seconds	>0.0	TAUK	1	1
	TAUØL	τ_{oL}	Seconds	≥ 0.0	TAUØK	1	1
	ZRL	z_{RL}	Meters	≥ 2.0	ZRK	1	1
	UBARL	$\bar{u}_{BL}$ & $\bar{u}_{TL}$	Meters Sec^{-1}	≥ 0.0	UBARK(JBØT & JTØP)	11	1

TABLE B-1 (Continued)

NAMELIST	FORTRAN	Model	Units	Limits	Value (3)	Array Size (7)	Logic Section
NAM3 (8)	SIGAL	$\sigma_{ABL}\{\tau_{oL}\}$ & $\sigma_{ATL}\{\tau_{oL}\}$	Degrees	≥ 0.0	SIGAK(JBØT & JTØP)	11	1
	SIGEL	σ_{EBL} & σ_{ETL}	Degrees	≥ 0.0	SIGEK(JBØT & JTØP)	11	1
	THETAL	θ_{BL} & θ_{TL}	Degrees	≥ 0 & ≤ 360.0	THETAK(JBØT & JTØP)	11	1

(1) See Section B.4.2 of Appendix B for the range of values of the ISKIP options.

(2) Units depend on model; see Section 4 in the main body of the report.

(3) The column under Value is used to simplify the program input deck by providing default values should the parameter be intentionally omitted in the first data case or set to zero. All parameters in Table B-1 remain their previous value for all subsequent cases executed in series unless changed in the input list.

(4) Units of dosage and concentration isopleth values must be consistent with the equation units whether output is in grams/meter^3, parts per million, etc.

(5) These parameters must have values other than zero only if they are used by the logic section selected and only in the applicable layers.

(6) See Section B.4.2 of Appendix B on the description of ACCUR.

(7) Several variables are dimensioned to a larger value in the program, but the extra space is used for other purposes.

(8) The namelist NAM3 is read only if ISKIP(2) equals 3 and NBK is greater than zero. Caution must be used when selecting this option.

TABLE B-1 (Continued)

(9) The default value of NYS depends on the spread between the minimum THETAK or THETAL and the maximum THETAK or THETAL. NYS = $\left[(\mathrm{DELPHI}/2 + \mathrm{MAX}) - (\mathrm{MIN} - \mathrm{DELPHI}/2)\right]/5.0$.

(10) The default values of XX and DXR are: 500, 600, 700, 800, 900, 1000, 1250, 1500, 1750, 2000, 2500, 3000, 3500, 4000, 5000, 6000, 7000, 8000, 9000, 10000, 12500, 15000, 17500, 20000, 25000, 30000, 35000, 40000, 50000, 60000, 70000, 80000, 90000, 100000 meters. Default values of XX and/or DXR are used only if NXS and/or NDXR are set to 0 respectively.

(11) The default values of the YY are determined from the maximum THETAK or THETAL plus DELPHI/2 degrees and the minimum THETAK or THETAL minus DELPHI/2 degrees and are placed at 5-degree intervals. These values of YY are used only if NYS = 0. If NYS is set to 1, the program attempts to use the mean wind direction in the layer (see NYS in Section B.4.2).

NAMELIST	-	Name of the Fortran NAMELIST list to which the variables belong.
FORTRAN	-	Fortran symbolic notation defining the program input.
MODEL	-	Mathematical notation corresponding to the Fortran notation.
UNITS	-	Dimensional units of the input parameters.
LIMITS	-	Numerical limits on input values.
VALUE	-	Default value should the parameter have a present value of 0.
ARRAY SIZE	-	Maximum number of core locations for the input parameter.
LOGIC SECTION	-	Logic section in which the variable is used.

B.3 DATA INPUT METHOD

This program uses the Fortran NAMELIST method of inputting data. Input data must be in a specific form in order to be read using a NAMELIST list. The first character in each card to be read must be blank. The first card in each NAMELIST list contains the NAMELIST name preceded by the character $ (or & on the IBM 360). The last card in each NAMELIST list contains $END (&END on IBM 360) to terminate the list. The form of the remaining data items in the list may be:

a. *Variable Name = Constant* - The *variable name* may be a subscripted array name or a single variable name. Subscripts must be integer constants. The *constant* may be integer, real or Hollerith (nH *alphanumeric characters*) data.

b. *Array Name = Set of Constants* (separated by commas) - The *array name* is not subscripted. The *set of constants* consists of constants of the type integer or real. The number of constants must be less than or equal to the array size. Successive occurrences of the same constant can be represented in the form *k* constant*.

The sequence of the input data parameters within the list is not significant. A more detailed explanation of the Fortran NAMELIST can be found in any Fortran language manual. Section B. 8 shows two example input data coding sheets. All program input parameters are set to zero prior to input of the first case. Parameters that are not used or have default values need not appear in the input deck. When multiple cases are stacked, all parameters retain their values from the last case and are changed only by input.

B. 4 EXPLANATION OF PROGRAM INPUTS

This section contains a complete description of all program input parameters.

B. 4. 1 NAMELIST NAM1

DATE - Run date consisting of up to 12 alphanumeric (Hollerith) characters.

NP - Number of cases of input information. The NAMELIST NAM2 (followed by NAM3 if selected) is repeated NP times.

B. 4. 2 NAMELIST NAM2

TESTNØ - Case titling information consisting of up to 72 alphanumeric (Hollerith) characters.

ISKIP(1) - This option controls the execution of Logic Section 5 for gravitational deposition, Model 6.

a. If this option is set to 0, Logic Section 5, Model 6 is not executed.

b. If this option is set to 1, gravitational deposition (Model 6) is executed.

c. If this option is set to 2, gravitational deposition (Model 6) is executed and assumes a destruct or explosion occurs in the top layer.

ISKIP(2) - This option controls the execution of Logic Section 1 where dosage, concentration, time mean concentration, time of passage, and average cloud concentration patterns are calculated over a reference grid system using any one of or a combination of Models 1 through 5.

a. If this option is set to 0, Logic Section 1 is not executed unless ISKIP(7) is set to 1, 3 or 4.

b. If set greater than or equal to 1, Logic Section 1 with all selected models is executed.

c. If it is desired to input the layer step change parameters for Model 4 rather than automatically calculate them, ISKIP(2) must be set to 3.

ISKIP(3) - This option controls the execution of Logic Section 2 where centerline dosage, maximum centerline concentration, centerline time-mean concentration, time of passage and centerline average cloud concentration are calculated downwind of the source along the cloud axis. This option is only available for Models 1, 2 and/or 3. For maximum centerline values from Model 4, see NYS below. See the explanation of DXR below when using the ISKIP(3) option.

a. If this option is set to 0, Logic Section 2 is not executed.

b. If set to 1, dosage and concentration are calculated at all specified heights.

ISKIP(4) - This option controls the execution of Logic Section 3 where isopleths of dosage and concentration are calculated in the horizontal plane about the downwind cloud axis. This option is only available for Models 1, 2 and/or 3.

a. If this option is set to 0, Logic Section 3 is not executed.

b. If set to 1, only dosage isopleths at ground level are calculated.

c. If set to 2, only dosage isopleths at the specified layer boundaries are calculated.

d. If set to 3, only dosage isopleths at all specified calculation heights are calculated.

e. If set to 4, only concentration isopleths at ground level are calculated.

f. If set to 5, only concentration isopleths at the specified layer boundaries are calculated.

g. If set to 6, only concentration isopleths at all specified calculation heights are calculated.

h. If set to 7, 8 or 9, dosage and concentration isopleths are calculated at ground level, specified layer boundaries or all specified calculation heights, respectively. (See the explanation of DXR below when using the ISKIP(4) option.)

ISKIP(5) - This option controls the execution of Logic Section 4 where isopleths of dosage and concentration are calculated in the

vertical plane about the downwind cloud axis. This option is available only for Models 1, 2 and/or 3.

a. If this option is set to 0, Logic Section 4 is not executed.

b. If set to 1, only dosage isopleths are calculated.

c. If set to 2, only concentration isopleths are calculated.

d. If set to 3, both dosage and concentration isopleths are calculated.

(See the explanation of DXR and IFLAG below when using the ISKIP(5) option.)

ISKIP(6) - This option controls the model calculations of dosage and concentration with simple decay.

a. If this option is set to 0, the decay term is not included.

b. If set to 1, the decay term is included in all model calculations in Logic Sections 1 through 4.

ISKIP(7) - This option controls the calculation of deposition on the ground (Model 5) due to precipitation scavenging and dosage and concentration with cloud depletion due to precipitation scavenging.

a. If this option is set to 0, precipitation scavenging and deposition are not calculated.

b. If set to 1, the maximum possible deposition on the ground is calculated. (Logic Section 1 only.)

c. If set to 2, dosage and concentration with depletion due to precipitation scavenging is calculated (Logic Sections 1 through 4).

d. If set to 3, deposition due to precipitation scavenging at ground level is calculated (Logic Section 1 only).

e. If set to 4, both (c) and (d) above are calculated (Logic Section 1 only).

The above ISKIP options cannot be combined in certain problem runs. Allowable combinations of these options and possible models are shown in Table B-2.

NXS - Number of radial distances XX on the reference grid system. If NXS is set to 0, the default value of 34 is used for NXS and the XX array is automatically filled (used only in Logic Sections 1 and 5).

NYS - Number of angular coordinates YY on the reference grid system. If NYS is set to 0, NYS is calculated and the YY are determined from the mean layer wind directions. If NYS is set to 1, the program will calculate only the cloud centerline axis. The program will do this only if the source is located at the origin and if Model 4 is selected t* (TAST) must occur at less than 1.2 seconds. (Used only in Logic Sections 1 and 5, and with the NYS = 1 option only in 1.)

NZS - Total number of initial layer boundaries.

NDI - Number of dosage values for which isopleths are to be calculated in the horizontal and/or vertical planes. (Used only in Logic Sections 3 and 4.)

NCI - Number of concentration values for which isopleths are to be calculated in the horizontal and/or vertical planes. (Used only in Logic Sections 3 and 4.)

TABLE B-2

ALLOWABLE ISKIP AND MODEL COMBINATIONS FOR ANY ONE CASE PROBLEM AT A PARTICULAR LAYER

ISKIP Selected		Allowable ISKIP and Model Combinations													
		ISKIP(1) =1 or 2	ISKIP(2) = 1 or 3				ISKIP(3) = 1		ISKIP(4) = 1 to 9		ISKIP(5) = 1, 2 or 3		ISKIP(6) = 1	ISKIP(7) = 2	1,3 or 4
	Model	6	1 or 2	3	(1 or 2) & 4	3 and 4	1 or 2	3	1 or 2	3	1 or 2	3	--	--	5
ISKIP(1) = 1 or 2	6	Y	N	N	N	N	N	N	N	N	N	N	N	N	N
ISKIP(2) = 1 or 3	1 or 2	N	Y	N	N	N	Y	N	Y	N	Y	N	Y	Y	Y
	3	N	N	Y	N	N	N	Y	N	Y	N	Y	Y	Y	Y
	(1 or 2) and 4	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	Y	Y
	3 and 4	N	N	N	N	Y	N	Y	N	Y	N	Y	Y	Y	Y
ISKIP(3) = 1	1 or 2	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	Y	N
	3	N	N	Y	N	Y	N	Y	N	Y	N	Y	Y	Y	N
ISKIP(4) = 1 to 9	1 or 2	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	Y	N
	3	N	N	Y	N	Y	N	Y	N	Y	N	Y	Y	Y	N

N = NO
Y = YES

TABLE B-2 (Continued)

ISKIP Selected		Allowable ISKIP and Model Combinations													
		ISKIP(1) = 1 or 2	ISKIP(2) = 1 or 3				ISKIP(3) = 1		ISKIP(4) = 1 to 9		ISKIP(5) = 1, 2 or 3		ISKIP(6) = 1	ISKIP(7) = 2	ISKIP(7) = 1,3 or4
	Model	6	1 or 2	3	(1 or 2) & 4	3 and 4	1 or 2	3	1 or 2	3	1 or 2	3	--	--	5
ISKIP(5) = 1, 2 or 3	1 or 2	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	Y	N
	3	N	N	Y	N	Y	N	Y	N	Y	N	Y	Y	Y	N
ISKIP(6) = 1	-	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
ISKIP(7) = 2	-	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
ISKIP(7) = 1, 3 or 4	5	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	Y

N = NO
Y = YES

NDXR - Number of radial distances input for all calculations in Logic Sections 2, 3 and 4. (Default value is 34 and DXR is automatically filled.)

NBK - Number of distinct new layers in the layer step (structure) change for Model 4. All new layers are formed by combining two or more of the initial layers into one new layer. (Logic Section 1, Model 4 only.)

NPTS - Number of heights at which calculations are to be performed for Logic Sections 1 through 4. (Default value is NZS -1.)

NVS - Number of droplet or particle terminal fall velocities used to calculate ground-level gravitational deposition from all layers except the layer in which a destruct occurs. (Logic Section 5, Model 6 only.)

NVB - Number of droplet or particle terminal fall velocities used to calculate ground-level gravitational deposition from the layer in which a vehicle destruct occurs. (Logic Section 5, Model 6 only.)

XX - Array of radial distances for the coordinates of the reference grid system used in Logic Sections 1 and 5. (Default values are given in Table B-1 of Appendix B and default values are used only if NXS = 0.)

YY - Array of angular distances for the coordinates of the reference grid system used in Logic Sections 1 and 5. (Default values are given in Table B-1 of Appendix B and default values are used only if NYS = 0 or 1.)

Z - Array of layer boundary heights.

DXR - Array of radial distances along the cloud axis used for calculations in Logic Sections 2, 3 and 4.

DELX - Array of the radial distances to the source location in each layer.

DELY - Array of the angular distances to the source location in each layer measured clockwise from zero degrees north.

Q - Source strength for each initial layer.

UBARK - Mean wind speed at ZRK followed by the mean wind speed at the top of each layer.

SIGAK - Standard deviation of the wind azimuth angle for reference time τ_{oK} at ZRK followed by the standard deviation of the wind azimuth angle at the top of each layer.

SIGEK - Standard deviation of the wind elevation angle at ZRK followed by the standard deviation of the wind elevation angle at the top of each layer.

SIGXØ - Standard deviation of the alongwind concentration distribution of the source in the layer (alongwind source dimension).

SIGYØ - Standard deviation of the crosswind concentration distribution of the source in the layer at a downwind distance XLRY from the true source (crosswind source dimension).

SIGZØ - Standard deviation of the vertical concentration distribution of the source in the layer at a downwind distance XLRZ

from the true source (vertical source dimension). (Default value = $\left[z(K+1) - z(K)\right] / \sqrt{12}$.)

ALPHA - Lateral diffusion coefficient in the layer. (Default value is 1.0.)

BETA - Vertical diffusion coefficient in the layer. (Default value is 1.0.)

ZRK - Reference height in the surface layer for meteorological measurements. (Default value is 2.)

TIMAV - Time over which time-mean concentration and average cloud concentration are calculated. (Logic Section 1 only; also, default is 600.0.)

THETAK - Mean wind direction at ZRK followed by the mean wind direction at the top of each layer.

TAUK - Time required for cloud stabilization in the layers (source emission time).

TAUØK - Reference time for the standard deviations of the wind azimuth angle SIGAK. (Default value is 600.0.)

H - Effective source height in each layer (Model 3 only).

XRY - Distance downwind from the virtual point source over which rectilinear expansion in the lateral occurs. (Default value is 100.0.)

XRZ - Distance downwind from the virtual point source over which rectilinear expansion in the vertical occurs. (Default value is 100.0.)

XLRY - Reference distance from the true source at which SIGYØ is measured. (Default value is 0.0.)

XLRZ - Reference distance from the true source at which SIGZØ is measured. (Default value is 0.0.)

ZZL - Vertical calculation heights. This parameter can include any heights within the initial layer structure. (Used in Logic Sections 1 through 4.)

IZMØD - Model selection array identifying the model to use in each initial layer. (Used in Logic Sections 1 through 4 with a default value of 1.)

DECAY - Coefficient of time-dependent decay. (Used in Logic Sections 1 through 4.)

ZLIM - Maximum height through which precipitation scavenging can occur. This parameter must be set to a value equal to the upper boundary of the uppermost layer in which precipitation occurs. (Used in Logic Sections 1 through 4.)

TIM1 - Time at which precipitation begins. (Used in Logic Sections 1 through 4.)

BLAMDA - Precipitation scavenging (washout) coefficient. (Logic Sections 1 through 4.)

IFLAG - Array used to indicate at which radial distances vertical isopleths are to be calculated. (Logic Section 4.)

a. If IFLAG(I) is set to 0, the I^{th} distance DXR(I) is ignored.

b. If the I^{th} value of IFLAG is set to 1, isopleths are calculated at DXR(I).

DI - Dosage values for which isopleth half-widths measured from the cloud centerline are calculated. (Logic Sections 3 and 4.)

CI - Concentration values for which isopleth half-widths measured from the cloud centerline are calculated. (Logic Sections 3 and 4.)

TAST - Time of layer structure change. (Logic Section 1 only)

JBØT - Bottom layer of each distinct new layer formed by layer structure change. New layers are formed by two or more of the initial layers. (Logic Section 1 only.)

JTØP - Top layer of each distinct new layer formed by layer structure change. (Logic Section 1 only.)

VS - Droplet or particle terminal fall velocity distribution used in all layers except a layer in which a vehicle destruct occurs. (Logic Section 5.)

PERC - Frequency of occurrence of each velocity category VS. (Logic Section 5.)

ACCUR - Accuracy constant for the line source simulation used in Model 6, Logic Section 5. A value of 0.45 ensures that the calculated ground deposition is within 10 percent of the deposition expected from a vertical line source. If set to 0.32, the calculated deposition is within 5 percent of that expected from a vertical line source.

VB - Droplet or particle terminal fall velocity distribution used in the layer in which a vehicle destruct occurs. The layer must be the top layer. (Logic Section 5.)

PERCB - Frequency of occurrence of each velocity category VB. (Logic Section 5.)

HB - Height at which a vehicle destruct occurs. (Logic Section 5.)

T - Residence time of vehicle in the layer. (Logic Section 5.)

DELPHI - Width of calculation sector. (Logic Sections 1 and 5 and the default value is 180.0.)

B.4.3 NAMELIST NAM3

The layer step change parameters in this list are read only if ISKIP(2) is set to 3 and NBK is greater than zero. These parameters are calculated automatically otherwise. (All parameters are applicable to Logic Section 1 only.)

ALPHL - Lateral diffusion coefficient in each new layer. (Default value is 1.)

BETL - Vertical diffusion coefficient in each new layer. (Default value is 1.)

TAUL - Time required for cloud stabilization in the new layers.

TAUØL - Reference time for the standard deviation of the wind azimuth angle SIGAL in the new layers. (Default value is 600.0.)

ZRL - Reference height in the surface layer for meteorological measurements. This must be set only if the bottom new layer includes the initial surface layer. (Default value is 2.0.)

UBARL - Mean wind speed at the bottom and top boundaries of each new layer. These values are input in ascending order of new layers with the value at the top boundary preceded by the bottom. If the bottom new layer contains the initial surface layer, UBARL at ZRL should be input as the bottom value of this layer.

SIGAL - Standard deviation of the wind azimuth angle for reference time τ_{oL} at the bottom and top boundaries of each new layer. If the bottom new layer contains the initial surface layer, SIGAL at ZRL should be input as the bottom value of this layer.

SIGEL - Standard deviations of the wind elevation angle at the bottom and top boundaries of each new layer. If the bottom new layer contains the initial surface layer, SIGEL at ZRL should be input as the bottom value of this layer.

THETAL - Mean wind direction of the bottom and top boundaries of each new layer. If the bottom new layer contains the initial surface layer, THETAL at ZRL should be input as the bottom value of this layer.

B.5 ADDITIONAL COMMENTS

The NASA/MSFC Multilayer Diffusion Model has been designed for use on a UNIVAC 1108 computer, but can be adapted to other computers with few modifications.

Two statements in Subroutine READER which assume six bytes per word must be changed to conform to the computer used. They are marked as machine dependent statements. The program uses quote marks to identify a Hollerith field in some format statements. The computer program uses the standard UNIVAC 1108 Fortran library functions EXP, SQRT, SIN, CØS, ALØG, ACØS and ABS. The names of some of these functions are different on other processors (CDC, IBM, etc.) requiring program changes. Subroutines in which these functions are used can be found by examining the External References table of each subroutine in the program listing in Appendix C. Also, in some program areas, division by zero can occur. When this happens, the program assumes that the result in the arithmetic register is zero and the error is ignored.

B.6 LINKAGE FOR SUBROUTINES IN COMPUTER PROGRAM FOR NASA/MSFC MULTILAYER DIFFUSION MODEL

The physical linkage for the computer program subroutines is shown in Figure B-1. Each connector represents a communication link between the subroutines.

B.7 LINKAGE FOR SUBROUTINES IN LOGIC SECTIONS 1 THROUGH 5

The linkage for subroutines used in Logic Sections 1 through 5 of the computer program for the NASA/MSFC Multilayer Diffusion Model is shown in Figure B-2. Each connector represents a communication link between the subroutines.

B.8 EXAMPLE INPUT DATA CODING SHEET

This section shows two example input data coding sheets. Example 1 shown in Figure B-3 is taken from a case problem in Section 6.2.1 of the main

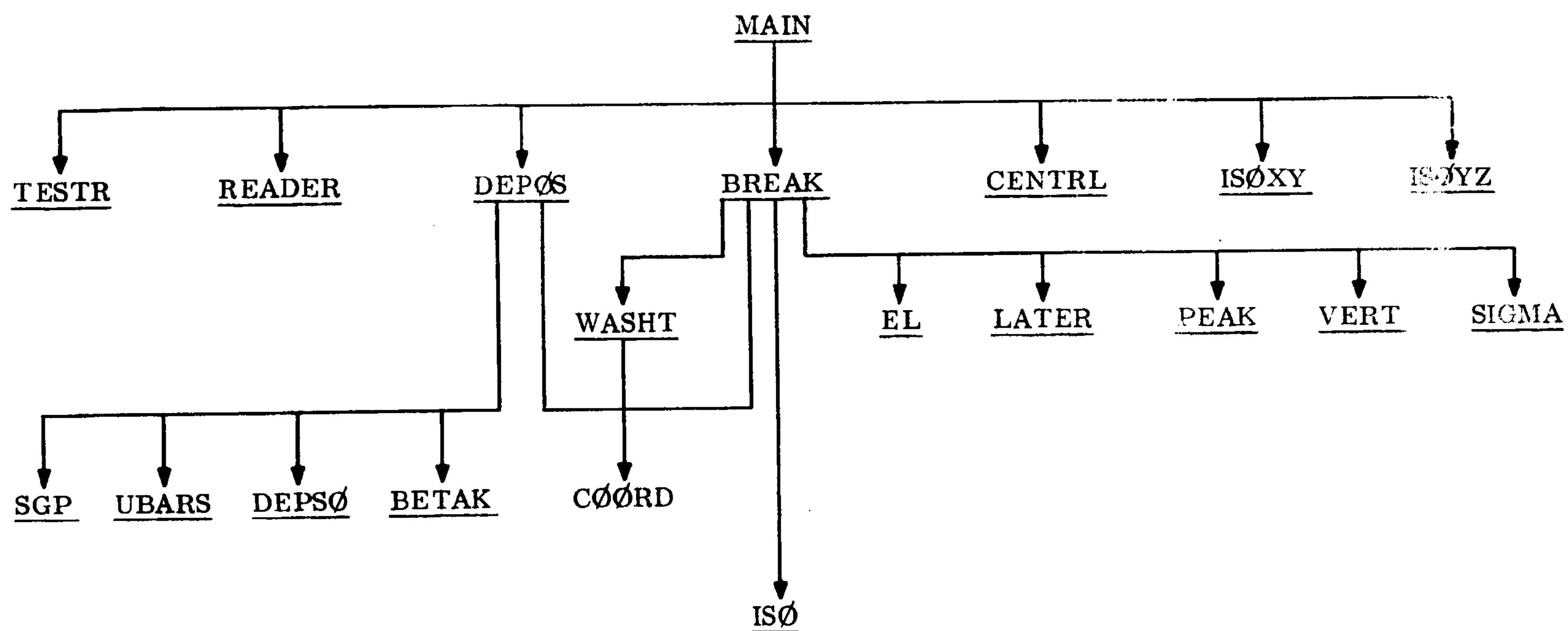


FIGURE B-1. Diagram of linkage between subroutines of computer program for NASA/MSFC Multilayer Diffusion Model.

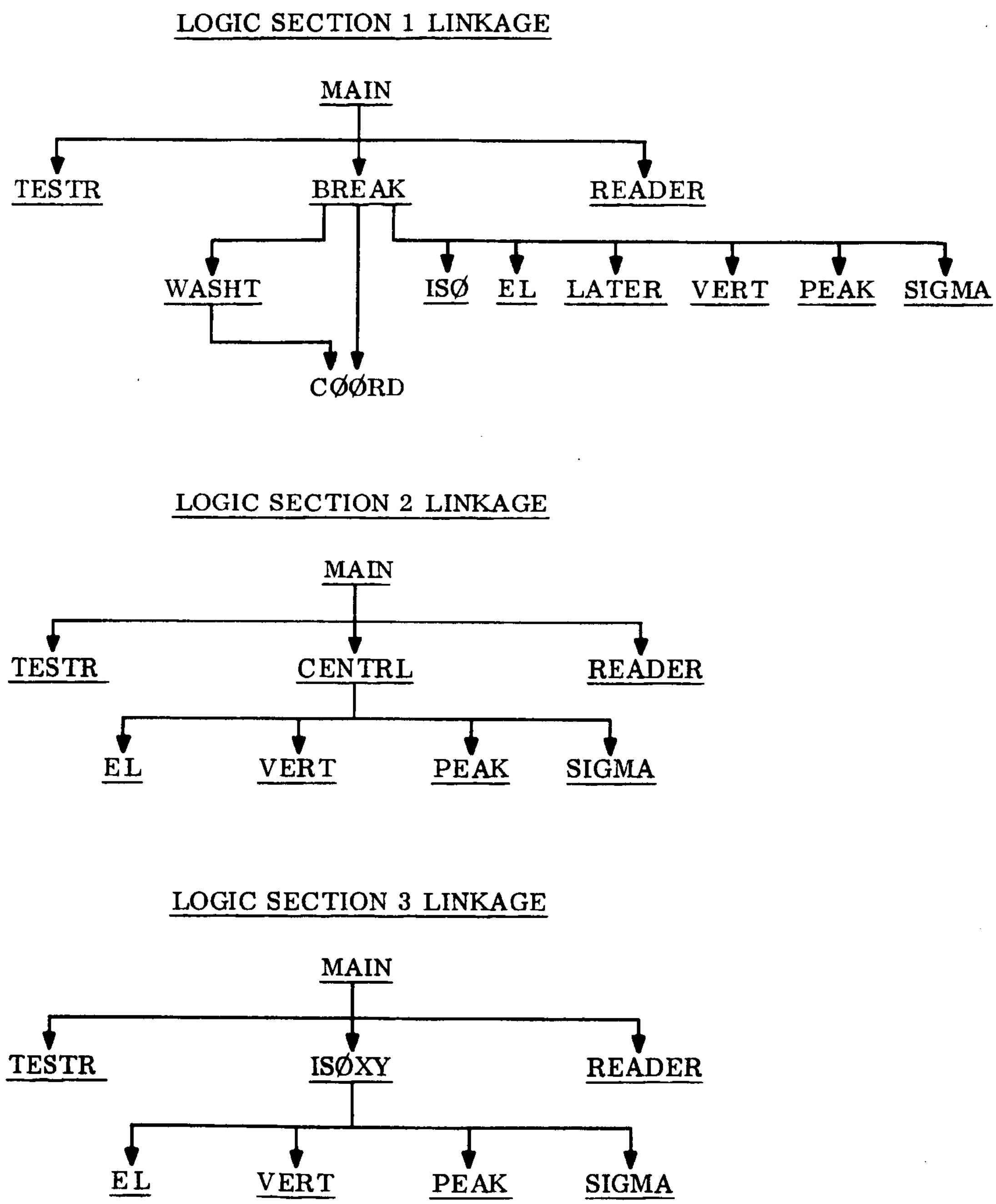
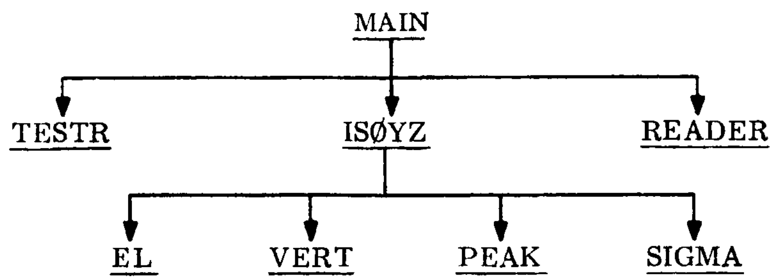


FIGURE B-2. Diagram of linkage between subroutines used in Logic Sections of computer program for the NASA/MSFC Multilayer Diffusion Model.

LOGIC SECTION 4 LINKAGE



LOGIC SECTION 5 LINKAGE

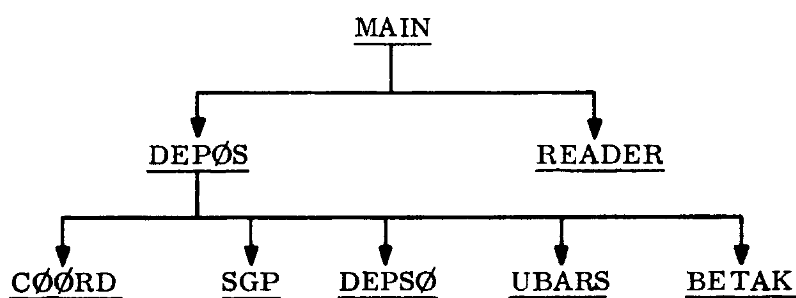


FIGURE B-2. (Continued)

```
$NAM1
DATE=11HMARCH 11 73,
NP=1,
$END
$NAM2
TESTNØ=55 HCONCENTRATION, NORMAL LAUNCH, SEA BREEZE CASE 1, H=832M,
ISKIP(2)=1,
NYS=1, NZS=12, NBK=1, NPTS=4,
Z=2,100,200,300,400,500,600,700,800,1300,1800,2300,
Q=1.44E5,3.49E5,9.66E5,2.27E6,4.55E6,7.77E6,1.13E7,1.39E7,9.61E6,5.4E5,
1.07E3,
UBARK=6,8.9,9.6,9.9,10.2,10.4,10.6,10.8,10.9,10.11.9,13.
SIGAK=8,5.41,5.05,4.85,4.71,4.61,4.52,4.45,4.39,2,1,1,
SIGEK=7.59,5.13,4.79,4.6,4.47,4.37,4.29,4.23,4.17,1.9,2*.95,
SIGXØ=14.88,44.65,74.42,104.19,133.95,163.72,193.49,223.26,182.77,2*93.
SIGYØ=14.88,44.65,74.42,104.19,133.95,163.72,193.49,223.26,182.77,2*93.
SIGZØ=8*28.87,2*144.34,115.17,
THETAK=3*150,152,153,157,160,170,180,228,240,250,
TAUK=461,
ZZL=2,800,1300,1800,
JBØT=1,JTØP=8,
$END
```

FIGURE B-3. Example 1 input data coding sheet.

body of this report with a sea-breeze meteorological situation and under normal launch conditions. The problem uses Model 4 to calculate dosage and concentration on the alongwind cloud axis. Necessary parameters for which a default value option was taken are not shown in Figure B-3. These parameters are NXS, XX, YY, DELX, DELY, ALPHA, BETA, ZRK, TIMAV, TAUØK, XRY, XRZ, XLRY, XLRZ, IZMØD and TAST. An example output listing for this problem is given in Appendix D, Example 1. Also, Example 3 in Appendix D is a duplicate of the above problem except dosage and concentration patterns in a 180-degree sector about the cloud axis were calculated by omitting the parameter NYS from the input (NYS = 0).

Example 2 shown in Figure B-4 is also taken from Section 6.2.1 in the main body of the report with a sea-breeze meteorological regime and for normal launch conditions. This problem uses Model 3 to calculate maximum centerline concentration and centerline dosage in Logic Section 2. A program output listing for these data is given in Appendix D, Example 2. Necessary parameters for which a default value option was taken are NDXR, DXR, DELX, DELY, ALPHA, BETA, ZRK, TIMAV, TAUØK, XRY, XRZ, XLRY and XLRZ.

```
 $NAM1
 DATE=11HMARCH 11 73,
 NP=1,
 $END
 $NAM2
 TESTNO=55HCONCENTRATION, NØRMAL LAUNCH, SEA BREEZE CASE 2., H=550M,
 ISKIP(3)=1,
 NZS=2,NPTS=2,
 Z=2,800,
 Q=4.18E9,
 UBARK=6,10.9,
 SIGAK=8.4,.39,
 SIGEK=7.59,4.17,
 SIGXØ=248,
 SIGYØ=248,
 SIGZØ=116,
 THETAK=150,180,
 TAUK=461,
 H=550,
 ZZL=2,550,
 IZMØD=3,
 $END
```

FIGURE B-4. Example 2 input data coding sheet.

APPENDIX C

COMPUTER PROGRAM LISTING

Appendix C contains a complete listing of the present configuration of the computer program for the NASA/MSFC Multilayer Diffusion Model, Version 2. The program is written in FORTRAN V and has been assembled and executed on a UNIVAC 1108 computer under the EXEC 8 Monitor.

```
@FOR,US MODEL
FOR 010L-05/30/73-13:16:09 (2,3)

   MAIN PROGRAM

   STORAGE USED: CODE(1) 001224; DATA(0) 001030; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003     PARAMT 002173
    0004     PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005     READER
    0006     DEPOS
    0007     TESTR
    0010     BREAK
    0011     CENTRL
    0012     ISOXY
    0013     ISOYZ
    0014     NINTR$
    0015     NWDU$
    0016     NI02$
    0017     NI01$
    0020     NSTOP$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001     000015 1176     0001     000055 134G     0001     000067 1376     0001     000537 149L     0001     000102 150G
    0001     000550 150L     0001     000554 151L     0001     000566 152L     0001     000572 153L     0001     000600 160L
    0001     000073 20L      0001     000632 210L     0001     000634 220L     0001     000674 310L     0001     000730 400L
    0001     000740 405L     0001     001025 406L     0001     001053 410L     0001     001053 420L     0001     000605 426G
    0001     000615 433G     0001     001056 434L     0001     001164 440L     0001     000041 5L       0001     001201 500L
    0001     001005 516G     0001     001207 540L     0001     001213 560L     0001     001123 566G     0001     001143 573G
    0001     001217 580L     0001     001153 601G     0001     001217 700L     0000     000017 902F     0000     000023 903F
    0000     000031 904F     0000     000036 905F     0000     000202 906F     0000     000213 907F     0000     000220 908F
    0000     000260 909F     0000     000272 910F     0000     000310 913F     0000     000322 915F     0000     000340 916F
    0000     000362 917F     0000     000366 918F     0000     000470 919F     0001     000172 92L      0000     000474 920F
    0000     000566 921F     0000     000656 922F     0000     000712 923F     0000     000747 924F     0000     000761 925F
    0001     000222 93L      0001     000234 94L      0001     000310 96L      0001     000344 97L      0001     000407 98L
    0003     001725 ACCUR    0003 R 001056 ALPHA      0003     001777 ALPHL    0004     001510 ALPHNK   0004     001034 ANG
    0004 R 001344 AVCON      0004 R 001200 AVMXCN     0003 R 001114 BETA      0004     001344 BETANK   0003     002011 BETL
    0003     001605 CI       0004 R 000264 CON        0003     000014 DATE     0003     001423 DECAY    0003 R 002172 DELPHI
    0004 R 000074 DELTHP     0004 R 000226 DELU       0003 R 000567 DELX      0003 R 000613 DELY      0004     000666 DEP
    0004     001656 DEPN     0003     001573 DI       0004 R 000667 DOS       0000 R 000012 DS1       0000 R 000013 DS2
    0000 R 000014 DS3        0000 R 000015 DS4        0000 R 000016 DS5       0003     000423 DXR      0003 R 001203 H
    0003     001776 HB       0004 I 000441 I          0004 I 000454 IBOT      0000 I 000007 ICHK      0003     001427 IFLAG
    0004     000665 II       0004 I 000450 ILK        0003 I 000016 ISKIP     0004 I 000502 ITAG      0004 I 000453 ITOP
    0003 I 001377 IZMOD      0004 I 000442 J          0003 I 001631 JBOT      0000 I 000006 JCHK      0004 I 000646 JF
    0003 I 001643 JTOP       0000 I 000001 JXJ        0000 I 000003 K         0004 I 000443 KK        0000 I 000002 KTK
    0004 R 000437 L          0003 R 001426 LAMBDA     0004 R 025276 LAT       0004 I 000652 LB1       0004 I 000657 LB2
    0000 I 000004 LSP        0004 R 000651 MPWR       0000 I 000011 N         0003 I 000062 NBK       0003     000060 NCI
    0003     000057 NDI      0003     000061 NDXR     0004 I 000452 NNZ       0000 I 000000 NP        0003 I 000063 NPTS
    0003     000065 NVH      0003     000064 NVS      0004     001655 NXCI    0003 I 000054 NXS       0003 I 000055 NYS
```

```
 0003     000056 NZS        0004 R 001510 PASSTM     0004     000432 PEAKD      0003     001701 PERC       0003     001752 PERCB
 0004     000647 PPWR       0003 R 000637 Q          0004     000650 QPWR       0004 R 000451 RAD        0003 R 000710 SIGAK
 0003 R 002052 SIGAL      0004     025444 SIGANK     0004 R 000036 SIGAP      0003 R 000735 SIGEK      0003 R 002076 SIGEL
 0004     025300 SIGENK     0004 R 000132 SIGEP      0004     000435 SIGX       0004     000501 SIGXNK     0003 R 000762 SIGXO
 0004     000434 SIGY       0004     025277 SIGYNK     0003 R 001006 SIGYO      0004     000433 SIGZ       0003 R 001032 SIGZO
 0004     001654 SGBAR      0004 R 000436 SQR2P      0004     000444 STO1       0004     000445 STO2       0004     000446 STO3
 0003     002146 T          0003 R 001617 TAST       0003 R 001201 TAUK       0003 R 002023 TAUL       0003 R 001202 TAUOK
 0003 R 002024 TAUOL      0003 I 000000 TESTNO     0004 R 000440 TH         0004 R 000170 THETA      0003 R 001154 THETAK
 0003 R 002122 THETAL     0003 R 001153 TIMAV      0003 R 001425 TIM1       0004 R 000447 TRD        0004 R 000000 UBAR
 0003 R 000663 UBARK      0003 R 002026 UBARL      0004     001200 UBARNK     0003     001726 VB         0004     000430 VER
 0004     000431 VREF       0003     001655 VS         0004 R 001656 WASHOU     0004     000455 XAST       0004     001033 XBARX
 0003 R 001231 XLRY       0003 R 001232 XLRZ       0003 R 001227 XRY        0003 R 001230 XRZ        0003 R 000066 XX
 0004     000667 YBARY      0000 R 000010 YCL        0000 R 000005 YKK        0003 R 000232 YY         0003 R 000376 Z
 0003 R 001424 ZLIM       0003 R 001152 ZRK        0003 R 002025 ZRL        0003 R 001233 ZZL
```

```
00100      1*     C     *****************************************************************MDL00100
00100      2*     C     *          NASA/MSFC MULTILAYER DIFFUSION MODEL, VERSION 2          *MDL00200
00100      3*     C     *****************************************************************MDL00300
00100      4*     C                                                                       MDL00400
00100      5*     C                                                                       MDL00500
00100      6*     C                                                                       MDL00600
00100      7*     C                                                                       MDL00700
00100      8*     C       ISKIP= PROGRAM CONTROL OPTIONS                                  MDL00800
00100      9*     C       H     = EFFECTIVE RELEASE HEIGHT IN LAYER (METERS)              MDL00900
00100     10*     C       Z     = BOUNDARY HEIGHTS OF LAYERS (METERS)                     MDL01000
00100     11*     C       Q     = SOURCE STRENGTH IN LAYER (MASS/HEIGHT)                  MDL01100
00100     12*     C       UBAR = CALCULATED TRANSPORT SPEED IN LAYER                      MDL01200
00100     13*     C       ALPHA = LATERAL POWER LAW EXPANSION COEFFICIENT                 MDL01300
00100     14*     C       BETA  = VERTICAL POWER LAW EXPANSION COEFFICIENT                MDL01400
00100     15*     C       SIGYO = STANDARD DEVIATION OF THE LATERAL SOURCE DIMENSION (METER)MDL01500
00100     16*     C       SIGAP = CALCULATED LATERAL DIFFUSION COEFFICIENT IN LAYER       MDL01600
00100     17*     C       SIGXO = STANDARD DEVIATION OF THE ALONG WIND SOURCE DIMENSION   MDL01700
00100     18*     C               (METERS)                                                MDL01800
00100     19*     C       DELTHP = CALCULATED WIND DIRECTION SHEAR IN LAYER               MDL01900
00100     20*     C       SIGZO  = STANDARD DEVIATION OF THE VERTICAL SOURCE DIMENSION    MDL02000
00100     21*     C               (METERS)                                                MDL02100
00100     22*     C       SIGEP = CALCULATED VERTICAL DIFFUSION COEFFICIENT               MDL02200
00100     23*     C       DELX = X COORDINATE OF SOURCE IN LAYER RELATIVE TO ORIGIN OF FIXEDMDL02300
00100     24*     C              POLAR GRID SYSTEM  (METERS)                              MDL02400
00100     25*     C       DELY = Y CORRDINATE OF SOURCE IN LAYER RELATIVE TO ORIGIN OF FIXEDMDL02500
00100     26*     C              POLAR GRID SYSTEM  (DEGREES)                             MDL02600
00100     27*     C       THETA = CALCULATED MEAN WIND DIRECTION IN LAYER                 MDL02700
00100     28*     C       IZMOD = MODEL NO TO USE IN LAYER (1,2 OR 3)                     MDL02800
00100     29*     C       DELU  = CALCULATED WIND SPEED SHEAR                             MDL02900
00100     30*     C       ZZL   = CALCULATION HEIGHTS IN LAYER                            MDL03000
00100     31*     C       DOS   = CALCULATED VALUE OF DOSAGE                              MDL03100
00100     32*     C       CON   = CALCULATED VALUE OF CONCENTRATION                       MDL03200
00100     33*     C       PEAKD = PART OF DOSAGE EQUATION                                 MDL03300
00100     34*     C       XX    = X COORDINATE OF CALCULATION POINT RELATIVE TO THE ORIGIN MDL03400
00100     35*     C               OF THE FIXED POLAR GRID SYSTEM  (METERS)                MDL03500
00100     36*     C       YY    = Y COORDINATE OF CALCULATION POINT RELATIVE TO THE ORIGIN MDL03600
00100     37*     C               OF THE FIXED POLAR GRID SYSTEM  (DEGREES)               MDL03700
00100     38*     C       POLAR)                                                          MDL03800
00100     39*     C       PLT  = CALCULATED VALUES OF DOSAGE AND CONCENTRATION ISOPLETHS  MDL03900
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00100  C   LAT   = LATERAL TERM OF DOSAGE EQUATION                                MDL04000
00100  C   VER   = VERTICAL TERM OF DOSAGE EQUATION                               MDL04100
00100  C   VREF  = REFLECTION TERM OF DOSAGE EQUATION                             MDL04200
00100  C   DXR = RADIAL DISTANCES FOR MAXIMUM PEAK DOSAGE AND CONCENTRATION      MDL04300
00100  C         AND ISOPLETH AND CLOUD HALF-WIDTH CALCULATIONS                   MDL04400
00100  C   T     = SOURCE EMISSION TIME IN LAYER FOR GRAVITATIONAL DEP. (SEC)MDL04500
00100  C   IFLAG = FLAG TO INDICATE AT WHICH DISTANCES DXR VERTICAL ISOPLETHSMDL04600
00100  C           ARE TO BE CALCULATED                                           MDL04700
00100  C   ITAG  = FLAG TO INDICATE WHICH RECEPTOR COORDINATES ARE OUTSIDE       MDL04800
00100  C           OF CALCULATION SECTOR DELPHI                                   MDL04900
00100  C   TESTNO = CASE TITLE                                                    MDL05000
00100  C    DI = DOSAGE ISOPLETH VALUES OF INTEREST                               MDL05100
00100  C    CI  = CONCENTRATION ISOPLETH VALUES OF INTEREST                       MDL05200
00100  C   SIGZ = CALCULATED STANDARD DEVIATION OF THE VERTICAL DOSAGE           MDL05300
00100  C          DISTRIBUTION                                                    MDL05400
00100  C   SIGY = CALCULATED STANDARD DEVIATION OF THE LATERAL DOSAGE            MDL05500
00100  C          DISTRIBUTION                                                    MDL05600
00100  C   SIGX = CALCULATED STANDARD DEVIATION OF THE ALONG WIND DOSAGE         MDL05700
00100  C          DISTRIBUTION                                                    MDL05800
00100  C   SQR2P =  SQUARE ROOT TWO PI                                            MDL05900
00100  C   L     = LENGTH OF CLOUD IN ALONG WIND DIRECTION                        MDL06000
00100  C   TH = THETA*PI/180                                                      MDL06100
00100  C   I     = INDEX OF X COORDINATES                                         MDL06200
00100  C   J     = INDEX OF Y COORDINATES                                         MDL06300
00100  C   KK    = INDEX OF LAYERS                                                MDL06400
00100  C   K = INDEX OVER CALCULATION HEIGHTS ZZL                                 MDL06500
00100  C   STO1  = TEMP STORAGE                                                   MDL06600
00100  C   STO2  = TEMP STORAGE                                                   MDL06700
00100  C   STO3  = TEMP STORAGE                                                   MDL06800
00100  C   TRD = HALF CALCULATION SECTOR DELPHI                                   MDL06900
00100  C   TAST  = TIME OF LAYER STRUCTURE CHANGE (SECONDS)                       MDL07000
00100  C   NBK = NO OF DISTINCT GROUPS OF LAYERS THAT FORM INTO ONE AT TIME      MDL07100
00100  C          TAST.                                                           MDL07200
00100  C   ILK  = INDEX ON NEW LAYERS AFTER TIME TAST                             MDL07300
00100  C   NXS  = NO OF X COORDINATES                                             MDL07400
00100  C   NYS  = NO OF Y COORDINATES                                             MDL07500
00100  C   NZS  = NO OF LAYER BOUNDARIES                                          MDL07600
00100  C   NDI  = NO OF DOSAGE ISOPLETHS                                          MDL07700
00100  C   NCI  = NO OF CONCENTRATION ISOPLETHS                                   MDL07800
00100  C   NDXR = NO OF RADIAL DISTANCES DXR ALONG CLOUD AXIS                     MDL07900
00100  C   NPTS = NO OF CALCULATION HEIGHTS ZZL                                   MDL08000
00100  C   RAD  = PI/180                                                          MDL08100
00100  C   NNZ  = NZS-1 NO OF LAYERS                                              MDL08200
00100  C   ITOP  = TOP OF NEW LAYER AFTER TAST IN TERMS OF OLD LAYER STRUCTURMDL08300
00100  C   IBOT  = BOTTOM OF NEW LAYER AFTER TAST IN TERMS OF OLD LAYER          MDL08400
00100  C          STRUCTURE (ITOP AND IBOT INDEXES)                               MDL08500
00100  C   XAST  = CALCULATE DISTANCE TO TAST                                     MDL08600
00100  C   SIGXNK = SIGX OF NEW LAYER STRUCTURE                                   MDL08700
00100  C   LAMBDA = WASHOUT COEFFICIENT                                           MDL08800
00100  C   TIM1 = TIME OF START OF RAIN (SECONDS)                                 MDL08900
00100  C   TIM2  = TIME RAIN STOPS (SECONDS)                                      MDL09000
00100  C   ZLIM  = MAXIMUM HEIGHT OF WASHOUT                                      MDL09100
00100  C   WASHOU = CALCULATE WASHOUT AT GROUND                                   MDL09200
00100  C   UBARK = WIND SPEED AT EACH LAYER BOUNDARY, LOWER BOUNDARY OF LAYERMDL09300
00100  C           1 FOR UBARK IS ASSUMED AT ZRK  (METERS/SEC)                   MDL09400
00100  C   SIGAK = SIGAP (INITIAL) AT EACH LAYER BOUNDARY, LOWER BOUNDARY OF MDL09500
00100  C           LAYER 1 FOR SIGAK IS ASSUMED AT ZRK (DEGREES)                 MDL09600
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00100     97*     C     SIGEK = SIGEP (INITIAL) AT EACH LAYER BOUNDARY, LOWER BOUNDARY OF MDL09700
00100     98*     C             LAYER 1 FOR SIGEK IS ASSUMED AT ZRK (DEGREES)              MDL09800
00100     99*     C     ZRK = REFERENCE HEIGHT IN SURFACE LAYER (METERS)                   MDL09900
00100    100*     C     THETAK = WIND DIRECTION AT LAYER BOUNDARIES (DEGREES)              MDL10000
00100    101*     C     TAUK  = TIME IN SECONDS REQUIRED FOR LATERAL CLOUD STABILIZATION   MDL10100
00100    102*     C     TAUOK = SAMPLING PERIOD IN SECONDS AT THE TOP OF THE LAYER         MDL10200
00100    103*     C     DECAY = DECAY COEFFICIENT IN DOSAGE EQUATION                       MDL10300
00100    104*     C     UBARL = WIND SPEED AT BOTTOM AND TOP OF EACH NEW LAYER AFTER LAYERMDL10400
00100    105*     C             CHANGE  (METERS/SEC)                                       MDL10500
00100    106*     C     SIGAL = SIGAP AT BOTTOM AND TOP OF EACH NEW LAYER AFTER LAYER      MDL10600
00100    107*     C             CHANGE  (DEGREES)                                          MDL10700
00100    108*     C     SIGEL = SIGEP AT BOTTOM AND TOP OF EACH NEW LAYER AFTER LAYER      MDL10800
00100    109*     C             CHANGE  (DEGREES)                                          MDL10900
00100    110*     C     ZRL = REFERENCE HEIGHT IN SURFACE LAYER OF NEW STRUCTURE (METERS)  MDL11000
00100    111*     C     THETAL = WIND DIRECTION AT BOTTOM AND TOP OF EACH NEW LAYER AFTER  MDL11100
00100    112*     C     TAUL  = TIME IN SECONDS FOR LATERAL CLOUD STABILIZATION IN NEW     MDL11200
00100    113*     C             LAYER STRUCTURE                                            MDL11300
00100    114*     C     TAUOL = TIME IN SECONDS OF SAMPLING PERIOD AT TOP OF NEW LAYER     MDL11400
00100    115*     C     JBOT  = INPUT LAYER NUMBER OF BOTTOM OF NEW LAYER STRUCTURE        MDL11500
00100    116*     C             RELATIVE TO OLD                                            MDL11600
00100    117*     C     JTOP  = INPUT LAYER NUMBER OF TOP OF NEW LAYER STRUCTURE           MDL11700
00100    118*     C             RELATIVE TO OLD                                            MDL11800
00100    119*     C     VS    = SETTLING VELOCITY IN GRAVITATIONAL DEPOSITION MODEL        MDL11900
00100    120*     C     PERC  = FREQUENCY OF VS                                            MDL12000
00100    121*     C     ACCUR = DESIRED ACCURACY COEFFICIENT (.45) INSURES THAT GROUND     MDL12100
00100    122*     C             DEPOSITION FROM NXCI POINT SOURCES IN THE LAYER VARIES     MDL12200
00100    123*     C             LESS THAN TEN PERCENT FROM DEPOSITION EXPECTED FROM A      MDL12300
00100    124*     C             VERTICAL LINE SOURCE IN THE LAYER. FOR (.32) REDUCED TO    MDL12400
00100    125*     C             FIVE PERCENT                                               MDL12500
00100    126*     C     VB    = SETTLING VELOCITIES FROM A BURST OR DESTRUCT IN LAYER NNZ  MDL12600
00100    127*     C     PERCB = FREQUENCY OF VB                                            MDL12700
00100    128*     C     HB    = HEIGHT OF BURST (METERS)                                   MDL12800
00100    129*     C     PPWR  = CALCULATED WIND SPEED POWER LAW EXPONENT                   MDL12900
00100    130*     C     QPWR  = CALCULATED SIGEP POWER LAW EXPONENT                        MDL13000
00100    131*     C     MPWR  = CALCULATED SIGAP POWER LAW EXPONENT                        MDL13100
00100    132*     C     DTHK  = WIND ANGLE SHEAR                                           MDL13200
00100    133*     C     NVS   = NUMBER OF SETTLING VELOCITIES VS                           MDL13300
00100    134*     C     NVB   = NUMBER OF SETTLING VELOCITIES VB                           MDL13400
00100    135*     C     DATE  = RUN DATE                                                   MDL13500
00100    136*     C     II    = INDEX ON VS AND VB                                         MDL13600
00100    137*     C     DEP   = TEMP STORAGE                                               MDL13700
00100    138*     C     YBARY = CALCULATED CORRDINATE OF POINT ON CLOUD AXIS OF VS AT      MDL13800
00100    139*     C             INTERSECTION WITH GROUND  (DEPOSITION)                     MDL13900
00100    140*     C     XBARX = CALCULATED CORRDINATE OF POINT ON CLOUD AXIS OF VS AT      MDL14000
00100    141*     C             INTERSECTION WITH GROUND  (DEPOSITION)                     MDL14100
00100    142*     C     UBARNK = CALCULATED WIND SPEED  (DEPOSITION)                       MDL14200
00100    143*     C     BETANK = CALCULATED BETA   (DEPOSITION)                            MDL14300
00100    144*     C     ALPHNK = CALCULATED ALPHA  (DEPOSITION)                            MDL14400
00100    145*     C     SQBAR  = TEMP STORAGE                                              MDL14500
00100    146*     C     ANG    =  ANGLE  TO POINT XBARX,YBARY  (DEPOSITION)                MDL14600
00100    147*     C     NXCI   = NUMBER OF POINT SOURCES IN LAYER  (DEPOSITION)            MDL14700
00100    148*     C     DEPN   = CALCULATED VALUE OF GRAVITATIONAL DEPOSITION              MDL14800
00100    149*     C     SIGYNK = SIGY OF NEW LAYER STRUCTURE IN CALCULATION OF DOSAGE AND  MDL14900
00100    150*     C              CONCENTRATION                                             MDL15000
00100    151*     C     SIGENK = CALCULATED SIGEP (DEPOSITION)                             MDL15100
00100    152*     C     SIGANK = CALCULATED SIGAP (DEPOSITION)                             MDL15200
00100    153*     C     TIMAV = CONCENTRATION AVERAGING TIME (SECONDS)                     MDL15300
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00100  C     AVCON = AVERAGE CONCENTRATION                                    MDL15400
00100  C     PASSTM = TIME OF CLOUD PASSAGE                                   MDL15500
00100  C     AVMXCN = MAXIMUM AVERAGE CONCENTRATION                           MDL15600
00100  C     XRY   = DISTANCE DOWNWIND FROM THE VIRTUAL POINT SOURCE OVER     MDL15700
00100  C             WHICH RECTILINEAR EXPANSION OCCURS LATERALLY   (METERS)  MDL15800
00100  C     XRZ   = DISTANCE DOWNWIND FROM THE VIRTUAL POINT SOURCE OVER     MDL15900
00100  C             WHICH RECTILINEAR EXPANSION OCCURS VERTICALLY  (METERS)  MDL16000
00100  C     XLRY  = DISTANCE FROM TRUE SOURCE TO POINT OF MEASUREMENT OF     MDL16100
00100  C             SIGYO  (METERS)                                          MDL16200
00100  C     XLRZ  = DISTANCE FROM TRUE SOURCE TO POINT OF MEASUREMENT OF     MDL16300
00100  C             SIGZO  (METERS)                                          MDL16400
00100  C                                                                      MDL16500
00100  C                  - PROGRAM INPUT PARAMETERS -                        MDL16600
00100  C     ISKIP, H, Z, Q, ALPHA, BETA, SIGYO, SIGZO, SIGXO, DELTHP, DELX,  MDL16700
00100  C     DELY, IZMOD, ZZL, XX, YY, DXR, T, IFLAG, TESTNO, DI, CI, TAST,   MDL16800
00100  C     NBK, NXS, NYS, NZS, NDI, NCI, NDXR, TIM1, ZLIM, UBARK, SIGAK,    MDL16900
00100  C     SIGEK, ZRK, THETAK, TAUK, TAUOU, DECAY, UBARL, SIGAL, SIGEL, ZRL, MDL17000
00100  C     THETAL, TAUL, TAUOL, JBOT, JTOP, VS, PERC, ACCUR, VB, PERCB, HB, MDL17100
00100  C     NVS, NVB, NPTS, DATE, TIMAV, LAMBDA, XRY, XRZ, XLRY, XLRZ,       MDL17200
00100  C        SOME OF THE ABOVE PARAMETERS ARE AUTOMATICALLY DETERMINED BY   MDL17300
00100  C        THE PROGRAM, CONSULT THE PROGRAM DOCUMENTATION TO DETERMINE    MDL17400
00100  C        WHICH THEY ARE. ALL INPUTS ARE READ VIA THE FORTRAN NAMELISTS  MDL17500
00100  C        NAM1, NAM2, NAM3 IN SUBROUTINE READER.                         MDL17600
00100  C                                                                      MDL17700
00100  C                                                                      MDL17800
00100  C     NOTE ALL REFERENCES TO GROUND REFER TO SOME SLIGHT DISTANCE ABOVE MDL17900
00100  C     THE GROUND AS A STARTING PLANE FOR ALL MODELS                    MDL18000
00100  C                                                                      MDL18100
00100  C                                                                      MDL18200
00101        COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI, MDL18300
00101       1NDXR,NBK,NPTS,NVS,NVB,XX(100),YY(100),Z(21),DXR(100),DELX(20),   MDL18400
00101       2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20), MDL18500
00101       3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)MDL18600
00101       4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,    MDL18700
00101       5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),      MDL18800
00101       6PERC(20),ACCUR,VB(20),PERCB(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL, MDL18900
00101       7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI        MDL19000
00103        COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),MDL19100
00103       1DELU(30),CON(100),VER,VREF,PEAKD,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,MDL19200
00103       2STO1,STO2,STO3,TRD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)MDL19300
00103       3,JF,PPWR,QPWR,MPWR,LB1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),MDL19400
00103       4UBARNK(100),BETANK(100),ALPHNK(100),SQBAR,NXCI,DEPN(100,100),LAT, MDL19500
00103       5SIGYNK,SIGENK(100),SIGANK(100)                                   MDL19600
00104        DIMENSION WASHOU(100,100),AVCON(100),PASSTM(100),AVMXCN(100),    MDL19700
00104       1DOS(100)                                                         MDL19800
00105        EQUIVALENCE (AVCON,BETANK),(PASSTM,ALPHNK),(AVMXCN,UBARNK),      MDL19900
00105       1(DOS,YBARY),(WASHOU,DEPN)                                        MDL20000
00106        REAL MPWR,L,LAT,LAMBDA                                           MDL20100
00107        INTEGER TESTNO                                                   MDL20200
00110        DATA LB1/'X IS',' RAD','IAL ','DIST','ANCE'/,LB2/'Y IS',' ANG','LEMDL20300
00110       1 I','N DE','GREE','S   '/                                        MDL20400
00110  C               *** INPUT SECTION ***                                  MDL20500
00113        CALL READER(1,NP)                                                MDL20600
00114        SQR2P = 2.5066283                                                MDL20700
00115        RAD = .01745329                                                  MDL20800
00115  C                       EXECUTE PROGRAM NP TIMES                       MDL20900
00116        DO 700 JXJ=1,NP                                                  MDL21000
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00116   211*     C                        READ MODEL PARAMETERS                     MDL21100
00121   212*           CALL READER(2,NP)                                            MDL21200
00122   213*           IF (ISKIP(1) .NE. 1.AND.ISKIP(1) .NE. 2) GO TO 5             MDL21300
00122   214*     C    .              EXECUTE GRAVITATIONAL DEPOSITION MODEL         MDL21400
00124   215*           CALL DEPOS(NP)                                               MDL21500
00125   216*           GO TO 700                                                    MDL21600
00126   217*         5 CONTINUE                                                     MDL21700
00127   218*           TRD = .5*DELPHI*RAD                                          MDL21800
00130   219*           ILK = 1                                                      MDL21900
00131   220*           IF (ISKIP(7) .EQ. 0) GO TO 20                                MDL22000
00133   221*           DO 10 I=1,NXS                                                MDL22100
00136   222*           DO 10 J=1,NYS                                                MDL22200
00141   223*        10 WASHOU(I,J) = 0.0                                            MDL22300
00144   224*        20 CONTINUE                                                     MDL22400
00145   225*           KTK = 1                                                      MDL22450
00146   226*           K = 1                                                        MDL22500
00147   227*           DO 500 KK=1,NNZ                                              MDL22600
00152   228*           TH = RAD*THETA(KK)                                           MDL22700
00152   229*     C               *** LIST INPUT PARAMETERS ***                      MDL22800
00153   230*           WRITE (6,903) KK                                             MDL22900
00156   231*           WRITE (6,904)                                                MDL23000
00160   232*           IF (KK .NE. 1) GO TO 92                                      MDL23100
00162   233*           WRITE (6,905) Q(KK),ZRK,UBARK(KK),UBARK(KK+1),SIGAK(KK),SIGAK(KK+1MDL23200
00162   234*          1),SIGEK(KK),SIGEK(KK+1),TAUK,TAUOK,SIGXO(KK),SIGYO(KK),SIGZO(KK), MDL23300
00162   235*          2THETAK(KK),THETAK(KK+1),Z(KK),ALPHA(KK),BETA(KK),H(KK),DELX(KK),  MDL23400
00162   236*          3DELY(KK),DELPHI,IZMOD(KK),TIM1,ZLIM,LAMBDA,TIMAV,XRY,XRZ,XLRY,XLRZMDL23500
00223   237*           GO TO 93                                                     MDL23600
00224   238*        92 CONTINUE                                                     MDL23700
00225   239*           WRITE (6,918) Q(KK),UBARK(KK),UBARK(KK+1),SIGAK(KK),SIGAK(KK+1),  MDL23800
00225   240*          1SIGEK(KK),SIGEK(KK+1),SIGXO(KK),SIGYO(KK),SIGZO(KK),THETAK(KK),   MDL23900
00225   241*          2THETAK(KK+1),Z(KK),ALPHA(KK),BETA(KK),H(KK),DELX(KK),DELY(KK),    MDL24000
00225   242*          3IZMOD(KK)                                                    MDL24100
00252   243*        93 IF (KK .NE. NNZ) GO TO 94                                    MDL24200
00254   244*           WRITE (6,919) Z(KK+1)                                        MDL24300
00257   245*        94 CONTINUE                                                     MDL24400
00260   246*           IF (NBK .EQ. 0.OR.KK .NE. JBOT(ILK)) GO TO 97                MDL24500
00262   247*           IF (JBOT(ILK) .NE. 1) GO TO 96                               MDL24600
00264   248*           LSP = ILK*2-1                                                MDL24700
00265   249*           WRITE (6,920) ZRL,UBARL(LSP),UBARL(LSP+1),SIGAL(LSP),SIGAL(LSP+1),MDL24800
00265   250*          1SIGEL(LSP),SIGEL(LSP+1),THETAL(LSP),THETAL(LSP+1),TAUL,TAUOL,     MDL24900
00265   251*          2ALPHA(NNZ+ILK),BETA(NNZ+ILK),TAST(ILK),JBOT(ILK),JTOP(ILK)   MDL25000
00307   252*           GO TO 97                                                     MDL25100
00310   253*        96 CONTINUE                                                     MDL25200
00311   254*           LSP = ILK*2-1                                                MDL25300
00312   255*           WRITE (6,921) UBARL(LSP),UBARL(LSP+1),SIGAL(LSP),SIGAL(LSP+1),    MDL25400
00312   256*          1SIGEL(LSP),SIGEL(LSP+1),THETAL(LSP),THETAL(LSP+1),ALPHA(NNZ+ILK), MDL25500
00312   257*          2BETA(NNZ+ILK),TAUL,TAUOL,TAST(ILK),JBOT(ILK),JTOP(ILK)       MDL25600
00333   258*        97 CONTINUE                                                     MDL25700
00334   259*           WRITE (6,922) UBAR(KK),THETA(KK),DELTHP(KK),DELU(KK),SIGAP(KK),   MDL25800
00334   260*          1SIGEP(KK)                                                    MDL25900
00344   261*           IF (NBK .EQ. 0.OR.KK.NE. JBOT(ILK)) GO TO 98                 MDL26000
00346   262*           WRITE (6,923) UBAR(NNZ+ILK),THETA(NNZ+ILK),DELTHP(NNZ+ILK),  MDL26100
00346   263*          1DELU(NNZ+ILK),SIGAP(NNZ+ILK),SIGEP(NNZ+ILK)                  MDL26200
00356   264*        98 CONTINUE                                                     MDL26300
00357   265*            CALL TESTR(KTK)                                             MDL26400
00360   266*           WRITE (6,917)                                                MDL26500
00362   267*           IF (ISKIP(2) .EQ. 0) GO TO 500                               MDL26600
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00364            IF (K .EQ. 1.AND.KK .EQ. 1) WRITE (6,909)                           MDL26700
00364      C                   *** GENERAL GRID PATTERN CALCULATIONS ***           MDL26800
00367            JF = NNZ+ILK-1                                                      MDL26900
00370            IF (K .GT. NPTS) GO TO 500                                          MDL27000
00372            IF (ZZL(K)-Z(KK+1)) 148,500,500                                     MDL27100
00375        148 YKK = 900.0                                                         MDL27200
00376            IF (DELX(KK) .GT. 0.0) GO TO 160                                    MDL27300
00400            IF (NBK .EQ. 0) GO TO 149                                           MDL27400
00402            IF (KK .LT. IBOT.OR.KK .GT. ITOP) GO TO 149                         MDL27500
00404            IF (TAST(ILK-1) .LT. 1.2.AND.KK .GE. IBOT.AND.KK.LE.ITOP)GO TO 151MDL27600
00406            GO TO 160                                                           MDL27700
00407        149 IF (THETA(KK) .GE. 180.0) GO TO 150                                 MDL27800
00411            YKK = THETA(KK)+180.0                                               MDL27900
00412            GO TO 153                                                           MDL28000
00413        150 YKK = THETA(KK)-180.0                                               MDL281
00414            GO TO 153                                                           MDL28200
00415        151 IF (THETA(JF) .GE. 180.0) GO TO 152                                 MDL28300
00417            YKK = THETA(JF)+180.0                                               MDL28400
00420            GO TO 153                                                           MDL28500
00421        152 YKK = THETA(JF)-180.0                                               MDL28600
00422        153 CONTINUE                                                            MDL28700
00423            IF (NYS .EQ. 1) YY(1) = YKK                                         MDL28800
00425        160 DO 434 I=1,NXS                                                      MDL28900
00430            JCHK = 0                                                            MDL29000
00431            ICHK = 0                                                            MDL29100
00432            DO 310 J=1,NYS                                                      MDL29200
00435            IF (JCHK .NE. 0) GO TO 210                                          MDL29300
00437            IF (YKK .GT. YY(J)) GO TO 210                                       MDL29400
00441            YCL = YKK                                                           MDL29500
00442            ICHK = 1                                                            MDL29600
00443            GO TO 220                                                           MDL29700
00444        210 YCL = YY(J)                                                         MDL29800
00445        220 N = 1                                                               MDL29900
00446            CALL BREAK(K,N,XX(I),YCL)                                           MDL30000
00447            IF (ICHK .EQ. 0) GO TO 310                                          MDL30100
00451            DS1 = DOS(J)                                                        MDL30200
00452            DS2 = CON(J)                                                        MDL30300
00453            DS3 = AVCON(J)                                                      MDL30400
00454            DS4 = PASSTM(J)                                                     MDL30500
00455            DS5 = AVMXCN(J)                                                     MDL30600
00456            JCHK = J                                                            MDL30700
00457            ICHK = 0                                                            MDL30800
00460            IF (YKK-YY(J)) 210,240,310                                          MDL30900
00463        240 JCHK = -1                                                           MDL31000
00464        310 CONTINUE                                                            MDL31100
00464      C                *****OUTPUT SECTION *****                               MDL31200
00466            IF (ISKIP(7) .EQ. 1.OR.ISKIP(7) .EQ. 3) GO TO 434                   MDL31300
00470            IF (I .NE. 1) GO TO 405                                             MDL31400
00472            IF (JCHK .NE. 0) GO TO 400                                          MDL31500
00474            WRITE (6,906) ZZL(K)                                                MDL31600
00477          , GO TO 405                                                           MDL31700
00500        400 WRITE (6,925) ZZL(K),YKK                                            MDL31800
00504        405 WRITE (6,907) XX(I)                                                 MDL31900
00507            IF (ISKIP(7) .EQ. 2.OR.ISKIP(7) .EQ. 4) WRITE (6,915)               MDL32000
00512            IF (ISKIP(6) .EQ. 1) WRITE(6,924)                                   MDL32100
00515            DO 420 J=1,NYS                                                      MDL32200
00520            IF (JCHK .NE. J) GO TO 406                                          MDL32300
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00522   325*          WRITE (6,908) YKK,DS1,DS2,DS3,DS4,DS5                               MDL32400
00532   326*      406 IF (ITAG(J) .EQ. 9.AND.NBK .EQ. 0) GO TO 410                        MDL32500
00534   327*          WRITE (6,908) YY(J),DOS(J),CON(J),AVCON(J),PASSTM(J),AVMXCN(J)      MDL32600
00544   328*          GO TO 420                                                           MDL32700
00545   329*      410 CONTINUE                                                            MDL32800
00546   330*      420 ITAG(J) = 0                                                         MDL32900
00550   331*      434 CONTINUE                                                            MDL33000
00552   332*      436 CONTINUE                                                            MDL33100
00553   333*          WRITE (6,917)                                                       MDL33200
00555   334*          IF (ISKIP(7) .EQ. 0.OR.ISKIP(7) .EQ. 2) GO TO 440                   MDL33300
00557   335*          IF (KK .NE. NNZ) GO TO 440                                          MDL33400
00561   336*          WRITE (6,910)                                                       MDL33500
00561   337*    C     PRINT WASHOUT DEPOSITION ONLY AT TOP                                MDL33600
00563   338*          WRITE (6,913)                                                       MDL33700
00565   339*          DO 438 I=1,NXS                                                      MDL33800
00570   340*          WRITE (6,916) XX(I),(YY(J),WASHOU(I,J),J=1,NYS)                     MDL33900
00600   341*          DO 438 J=1,NYS                                                      MDL34000
00603   342*          WASHOU(I,J) = 0.0                                                   MDL34100
00604   343*      438 CONTINUE                                                            MDL34200
00607   344*          WRITE (6,917)                                                       MDL34300
00611   345*      440 CONTINUE                                                            MDL34400
00611   346*    C                                                                         MDL34500
00612   347*          K = K+1                                                             MDL34600
00613   348*          IF (K .GT. NPTS) GO TO 500                                          MDL34700
00615   349*          IF (ZZL(K) .LT. Z(KK+1)) GO TO 160                                  MDL34800
00617   350*      500 CONTINUE                                                            MDL34900
00617   351*    C      ****CALCULATE CENTER LINE CONCENTRATION AND-OR DOSAGE ****         MDL35000
00621   352*          IF (ISKIP(3) .EQ. 0) GO TO 540                                      MDL35100
00623   353*          CALL CENTRL                                                         MDL35200
00624   354*      540 CONTINUE                                                            MDL35300
00624   355*    C                   ***** ISOPLETH SECTION *****                          MDL35400
00624   356*    C      **** CALCULATE ISOPLETHS X,Y PLANE ****                            MDL35500
00625   357*          IF (ISKIP(4) .EQ. 0) GO TO 560                                      MDL35600
00627   358*          CALL ISOXY                                                          MDL35700
00630   359*      560 CONTINUE                                                            MDL35800
00630   360*    C      **** CALCULATE ISOPLETHS Y,Z PLANE ****                            MDL35900
00631   361*          IF (ISKIP(5) .EQ. 0) GO TO 580                                      MDL36000
00633   362*          CALL ISOYZ                                                          MDL36100
00634   363*      580 CONTINUE                                                            MDL36200
00634   364*    C      **** LOOP FOR NEXT TEST *****                                      MDL36300
00635   365*      700 CONTINUE                                                            MDL36400
00637   366*      777 CONTINUE                                                            MDL36500
00640   367*      902 FORMAT (41X,5A4,', ',6A4)                                           MDL36600
00641   368*      903 FORMAT (1H0,55X,11H***** LAYER,I2,6H *****)                         MDL36700
00642   369*      904 FORMAT (1H0,57X,16H** INPUT DATA **)                                MDL36800
00643   370*      905 FORMAT ('0 Q=',E14.8,', ZRK=',F7.3,', UBAR AT BOTTOM=',F8.4,', UBAMDL36900
00643   371*         1R AT TOP=',F8.4,', SIGAK AT BOTTOM=',F8.5/' SIGAK AT TOP=',F8.5,',MDL37000
00643   372*         2 SIGEK AT BOTTOM=',F8.5,', SIGEK AT TOP=',F8.5,', TAUK=',F8.3,', TMDL37100
00643   373*         3AUOK=',F8.3/' SIGXO=',F9.4,', SIGYO=',F9.4,', SIGZO=',F9.4,', THETMDL37200
00643   374*         4AK AT BOTTOM=',F8.4,', THETAK AT TOP=',F8.4,', Z=',F9.3/' ALPHA=',MDL37300
00643   375*         5F4.2,' BETA=',F4.2,', H=',F9.3,', DELX=',E14.8,', DELY=',E14.8,', MDL37400
00643   376*         6DELPHI=',F8.4,', IZMOD=',I1,', TIM1=',E14.8/' ZLIM=',F9.3,', LAMBDMDL37500
00643   377*         7A=',F7.4,', TIMAV=',F8.3,', XRY=',F8.3,', XRZ=',F8.3,', XLRY=',F8.MDL37600
00643   378*         83,', XLRZ=',F8.3)                                                  MDL37700
00644   379*      906 FORMAT (1H0,48X,25H** CALCULATION HEIGHT Z =,F9.3,3H **)            MDL37800
00645   380*      907 FORMAT (1H0,57X,4H* X=,F10.2,2H *)                                  MDL37900
00646   381*      908 FORMAT (' ** Y=',F10.3,', DOSAGE=',E14.8,', CONCENTRATION=',E14.8,MDL38000
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00646    382*          1', TIME MEAN ALONGWIND CONCENTRATION=',E14.8/16X,'TIME OF PASSAGE=MDL38100
00646    383*          2',E14.8,', AVERAGE ALONGWIND CONCENTRATION=',E14.8)            MDL38200
00647    384*      909 FORMAT ('1',45X,'*-* DOSAGE AND CONCENTRATION PATTERNS *-*'/)       MDL38300
00650    385*      910 FORMAT ('1',32X,'*-* DEPOSITION AT GROUND-LEVEL DUE TO PRECIPITATIMDL38400
00650    386*          1ON SCAVENGING *-*'/)                                             MDL38500
00651    387*      913 FORMAT ('0',44X,'*** PRECIPITATION DEPOSITION AT GROUND ***')       MDL38600
00652    388*      915 FORMAT (32X,'* PRECIPITATION SCAVENGING IS INCLUDED IN DOSAGE AND MDL38700
00652    389*          1CONCENTRATION *'/)                                                MDL38750
00653    390*      916 FORMAT (' ** X=',F10.3,2(', Y=',F10.3,', DEPOSITION=',E14.8)/(18X,MDL38800
00653    391*          12('Y=',F10.3,', DEPOSITION=',E14.8)))                             MDL38900
00654    392*      917 FORMAT (12X,18(6H------)/)                                         MDL39000
00655    393*      918 FORMAT ('0 G=',E14.8,', UBAR AT BOTTOM=',F8.4,', UBAR AT TOP=',F8.MDL39100
00655    394*          14,', SIGAK AT BOTTOM=',F8.5,', SIGAK AT TOP=',F8.5/' SIGEK AT BOTTMDL39200
00655    395*          2OM=',F8.5,', SIGEK AT TOP=',F8.5,', SIGXO=',F9.4,', SIGYO=',F9.4,'MDL39300
00655    396*          3, SIGZO=',F9.4,', THETAK AT BOTTOM=',F8.4/' THETAK AT TOP=',F8.4,'MDL39400
00655    397*          4, Z=',F9.3,', ALPHA=',F4.2,', BETA=',F4.2,', H=',F9.3,', DELX=',E1MDL39500
00655    398*          54.8,', DELY=',E14.8/' IZMOD=',I1)                                 MDL39600
00656    399*      919 FORMAT (1X,10H Z AT TOP=,F10.4)                                    MDL39700
00657    400*      920 FORMAT ('0 ZRL=',F7.3,', UBARL AT BOTTOM=',F8.4,', UBARL AT TOP=',MDL39800
00657    401*          1F8.4,', SIGAL AT BOTTOM=',F8.5,', SIGAL AT TOP=',F8.5/' SIGEL AT BMDL39900
00657    402*          2OTTOM=',F8.5,', SIGEL AT TOP=',F8.5,', THETAL AT BOTTOM=',F8.4,', MDL40000
00657    403*          3THETAL AT TOP=',F8.4,', TAUL=',F8.3/' TAUOL=',F8.3,', ALPHL=',F4.2MDL40100
00657    404*          4,', BETL=',F4.2,', TAST=',E14.8,', JBOT=',I2,', JTOP=',I2)        MDL40200
00660    405*      921 FORMAT ('0 UBARL AT BOTTOM=',F8.4,', UBARL AT TOP=',F8.4,', SIGAL MDL40300
00660    406*          1AT BOTTOM=',F8.5,', SIGAL AT TOP=',F8.5/' SIGEL AT BOTTOM=',F8.5,'MDL40400
00660    407*          2, SIGEL AT TOP=',F8.5,', THETAL AT BOTTOM=',F8.4,', THETAL AT TOPMDL40500
00660    408*          3=',F8.4,', TAUL=',F8.3/' TAUOL=',F8.3,', ALPHL=',F4.2,', BETL=',F4MDL40600
00660    409*          4.2,', TAST=',E14.8,', JBOT=',I2,', JTOP=',I2)                     MDL40700
00661    410*      922 FORMAT (1H0,56HCALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UMDL40800
00661    411*          1BAR =,F10.5,9H, THETA =,F10.5,10H, DELTHP =,F10.5,8H, DELU =,F10.5MDL40900
00661    412*          2/1X,09H, SIGAP =,F10.5,9H, SIGEP =,F10.5)                         MDL41000
00662    413*      923 FORMAT (1H0,63HCALCULATED INPUT PARAMETERS FOR LAYER CHANGE MODELSMDL41100
00662    414*          1 **** UBAR =,F10.5,9H, THETA =,F10.5,10H, DELTHP =,F10.5/1X,8H DEMDL41200
00662    415*          2LU =,F10.5,9H, SIGAP =,F10.5,9H, SIGEP =,F10.5)                   MDL41300
00663    416*      924 FORMAT (41X,49H* DECAY IS INCLUDED IN DOSAGE AND CONCENTRATION *) MDL41400
00664    417*      925 FORMAT ('0',15X,'** CALCULATION HEIGHT Z=',F9.3,', CLOUD AXIS IS AMDL41500
00664    418*          1T',F8.3,' DEGREES AZIMUTH BEARING RELATIVE TO ORIGIN')            MDL41600
00665    419*          STOP                                                               MDL41700
00666    420*          END                                                                MDL41800

     END OF COMPILATION:        NO DIAGNOSTICS.
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@FOR,US BREAK
FOR 010L-03/14/73-21:37:15 (0,1)

   SUBROUTINE BREAK      ENTRY POINT 001070

   STORAGE USED: CODE(1) 001131; DATA(0) 000063; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003   PARAMT 002173
    0004   PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005   COORD
    0006   EL
    0007   SIGMA
    0010   PEAK
    0011   VERT
    0012   LATER
    0013   ISO
    0014   WASHT
    0015   EXP
    0016   NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001    000053 125L     0001    000222 127L     0001    000236 130L     0001    000243 135L     0001    000250 140L
    0001    000342 150L     0001    000440 160L     0001    000255 164G     0001    000443 165L     0001    000541 175L
    0001    000601 185L     0001    000727 195L     0001    000746 200L     0001    000433 230G     0001    000534 255G
    0001    000755 310L     0001    001014 311L     0001    001051 340L     0000 R  000010 AB       0003    001725 ACCUR
    0003    001056 ALPHA    0003    001777 ALPHL    0004    001510 ALPHNK   0004 R  001034 ANG      0000 R  000003 ASP
    0004 R  001344 AVCON    0004 R  001260 AVMXCN   0003    001114 BETA     0004    001344 BETANK   0003    002011 BETL
    0003    001605 CI       0004 R  000264 CON      0003    000014 DATE     0003 R  001423 DECAY    0003    002172 DELPHI
    0004    000074 DELTHP   0004    000226 DELU     0003    000567 DFLX     0003    000613 DELY     0004    000666 DEP
    0004    001656 DEPN     0003    001573 DI       0004 R  000567 DOS      0003    000423 DXR      0004 R  001045 ERFX
    0003    001203 H        0003    001776 HB       0004    000441 I        0004 I  000454 IBOT     0000 I  000012 IC1
    0000 I  000017 IC2      0000 I  000013 IC3      0003    001427 IFLAG    0004    000065 II       0004 I  000450 ILK
    0000    000037 INJP$    0000 I  000006 IS       0003 I  000016 ISKIP    0000 I  000005 ISW5     0004    000502 ITAG
    0004 I  000453 ITOP     0003 I  001377 IZMOD    0004 I  000442 J        0003    001531 JBOT     0004 I  000646 JF
    0003    001643 JTOP     0004 I  000443 KK       0004 R  000437 L        0003 R  001426 LAMBDA   0004 R  025276 LAT
    0004    000652 LB1      0004    000657 LB2      0000 I  000011 M        0004 R  000051 MPWR     0000 I  000016 MS
    0003 I  000062 NBK      0003    000060 NCI      0003    000057 NDI      0003    000061 NOXR     0000 I  000000 NF
    0004    000452 NNZ      0003    000063 NPTS     0003    000065 NVB      0003    000064 NVS      0004    001655 NXCI
    0003    000054 NAS      0003    000055 NYS      0003    000056 NZS      0004 R  001510 PASSTM   0004 R  000432 PEAKD
    0003    001761 PERC     0003    001752 PERCB    0004    000647 PPWR     0003 R  000037 Q        0004    000650 QPWR
    0004    000451 RAD      0003    000710 SIGAK    0003    002052 SIGAL    0004    025444 SIGANK   0004    000036 SI[illegible]
    0003    000735 SIGEK    0003    002076 SIGEL    0004    025300 SIGENK   0004    000132 SIGEP    0004 R  000435 SI[illegible]
    0004 R  000501 SIGXNK   0003    000762 SIGXO    0004 R  000434 SIGY     0004 R  025277 SIGYNK   0003    001006 SI[illegible]
    0004 R  000433 SIGZ     0003    001032 SIGZO    0004    001654 SOBAR    0004 R  000476 SOR2P    0004 R  000444 S[illegible]
    0004 R  000445 SIO2     0004 R  000446 STO3     0000 R  000014 S1       0000 R  000015 S2       0003    002146 T
    0003 R  001617 TAST     0003    001261 TAUK     0003    002023 TAUL     0003    001202 TAUOK    0003    002024 TA[illegible]
    0003 I  000000 TESTNO   0004    000440 TH       0004    000170 THETA    0003    001154 THETA[illegible] 0003    002122 T[illegible]
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 0003 R 001153 TIMAV     0003 R 001425 TIM1      0000 R 000007 TMPQ1     0000 R 000020 TMPQ2     0004   000447 TRD
 0004 R 000000 UBAR      0003   000663 UBARK     0003   002026 UBARL     0004   001200 UBARNK    0003   001726 VB
 0004 R 000430 VER       0004 R 000431 VREF      0003   001655 VS        0000 R 000001 X         0004   000455 XAST
 0004 R 001033 XBARX     0003   001231 XLPY      0003   001232 XLRZ      0003   001227 XRY       0003   001230 XRZ
 0000 R 000004 XS        0003   000066 XX        0000 R 000002 Y         0004   000667 YBARY     0003   000232 YY
 0003 R 000376 Z         0003 R 001424 ZLIM      0003   001152 ZRK       0003   002025 ZRL       0003 R 001233 ZZL


00101            SUBROUTINE BREAK(K,N,XO,YO)                                       BRK00100
00103            COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI, BRK00200
00103           1NDXR,NDK,NPTS,NVS,NVP,XX(100),YY(100),Z(21),DXR(100),DELX(20),    BRK00300
00103           2DELY(20),G(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20), BRK00400
00103           3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)BRK00500
00103           4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,     BRK00600
00103           5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),       BRK00700
00103           6PERC(20),ACCUR,VB(20),PERCB(20),H3,ALPHL(10),BETL(10),TAUL,TAUOL, BRK00800
00103           7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI         BRK00900
00104            COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),BRK01000
00104           1DELU(30),CON(100),VER,VREF,PEAKD,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,BRK01100
00104           2STO1,STO2,STO3,TRD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)BRK01200
00104           3,JF,PPWR,GPWR,HPWR,LB1(6),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),BRK01300
00104           4UBARNK(100),BETANK(100),ALPHNK(100),SQBAR,NXCI,DEPN(100,100),LAT, BRK01400
00104           5SIGYNK,SIGLNK(100),SIGANK(100)                                    BRK01500
00105            DIMENSION AVCON(100),PASSTM(100),AVMXCN(100),DOS(100),ERFX(6)     BRK01600
00106            EQUIVALENCE (AVCON,BETANK), (PASSTM,ALPHNK),                      BRK01700
00106           1(AVMXCN,UBARNK),(DOS,YBARY),(ANG(10),ERFX)                        BRK01800
00107            REAL HPWR,L,LAT,LAMBDA                                            BRK01900
00110            INTEGER TESTNO                                                    BRK02000
00110      C     *** THIS SUBROUTINE CALCULATES DOSAGE,CONCENTRATION AND WASHOUT **BRK02100
00110      C     *** ON A GENERAL GRID WITHIN THE SECTOR DELPHI.                   BRK02200
00111            NF = N                                                            BRK02300
00111      C     DETERMINE LOCATION OF RECEPTOR RELATIVE TO SOURCE AND WIND        BRK02400
00111      C     DIRECTION                                                         BRK02500
00112            CALL COORD(N,KK,X,Y,XO,YO,ASP,YS,1)                               BRK02600
00113            DOS(J) = 0.0                                                      BRK02700
00114            CON(J) = 0.0                                                      BRK02800
00115            ISWS = 0                                                          BRK02900
00116            IF (NDK .NE. 0.AND.IBOT .LE. KK.AND.KK .LE. ITOP) GO TO 135       BRK03000
00120            IS = 1                                                            BRK03100
00121            IF (N .EQ. 9) GO TO 310                                           BRK03200
00121      C                       CALCULATION OF MODELS 1,2,3                     BRK03300
00123        125 CALL EL(X,0)                                                      BRK03400
00124            CALL SIGMA(X,0,0)                                                 BRK03500
00125            CALL PEAK(NF,K)                                                   BRK03600
00126            CALL VERT(K,NF)                                                   BRK03700
00127            CALL LATER(Y)                                                     BRK03800
00130            ANG(5) = SIGY                                                     BRK03900
00131            ANG(6) = SIGX                                                     BRK04000
00132            IF (SIGY) 130,130,126                                             BRK04050
00135        126 IF (SIGZ .LE. 0.0.AND.IZMOD(KK) .EQ. 3) GO TO 130                 BRK04060
00137            TMPQ1 = X/UBAR(KK)                                                BRK04100
00140            DOS(J) = PEAKD*LAT*(VER+VREF)                                     BRK04200
00141            IF (ISKIP(6) .EQ. 1) DOS(J) = DOS(J)*EXP(-DECAY*TMPQ1)            BRK04300
00143            IF (ISKIP(7).LE.1.OR.ISKIP(7).EQ.3.OR.TIM1.GE.TMPQ1) GO TO 127    BRK04400
00145            IF (Z(KK) .GT. ZLIM) GO TO 127                                    BRK04500
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00147           AB = EXP(-LAMBDA*(TMPQ1-TIM1))
00150           DOS(J) = DOS(J)*AB
00151       127 CONTINUE
00152           ANG(1) = UBAR(KK)
00153           ANG(2) = SIGX
00154           CON(J) = DOS(J)*UBAR(KK)/(SQR2P*SIGX)
00155       130 IF (IS .EQ. 1) GO TO 310
00157           GO TO 140
00160       135 IS = 0
00161           IF (N .NE. 9) GO TO 125
00161     C     CALCULATION OF THE FULL TRANSITION MODEL, MODEL4
00163       140 DO 200 M=IBOT,ITOP
00165           ISW5 = 1
00167           N = NF
00170           CALL COORD(N,M,X,Y,XO,YO,ASP,XS,2)
00171           IF (N .EQ. 9) GO TO 200
00173           CALL EL(X,-1)
00174           CALL SIGMA(X,M,0)
00175           IF (M .EQ. KK) ANG(4) = SIGYNK
00177           STO1 = 1.414214*SIGZ
00200           TMPQ1 = 1.0/STO1
00201           STO2 = 0.0
00202           IF (SIGYNK) 200,200,147
00205       147 IF (SIGZ) 200,200,148
00210       148 IC1 = -1
00211           IC3 = 0
00212           S1 = -1.0
00213       150 S1 = S1+1.0
00214           S2 = 2.0*S1*(Z(ITOP+1)-Z(IBOT))
00215           ERFX(3) = (S2+2.0*Z(IBOT)-Z(M)-ZZL(K))*TMPQ1
00216           IF (ERFX(3) .GT. 3.0) IC3 = IC3+1
00220           IF (IC3 .GE. 2) GO TO 160
00222           ERFX(1) = (S2-Z(M)+ZZL(K))*TMPQ1
00223           ERFX(2) = (S2+Z(M+1)-ZZL(K))*TMPQ1
00224           ERFX(4) = (S2-2.0*Z(IBOT)+Z(M+1)+ZZL(K))*TMPQ1
00225           CALL ISO(1,4)
00226           IC1 = IC1 + 1
00227           DO 155 MS=1,4
00232       155 STO2 = STO2+ERFX(MS)
00234           GO TO 150
00235       160 S1 = 0.0
00236           IC2 = 0
00237           IC3 = 0
00240       165 S1 = S1+1.0
00241           S2 = 2.0*S1*(Z(ITOP+1)-Z(IBOT))
00242           ERFX(4) = (-S2-2.0*Z(IBOT)+Z(M+1)+ZZL(K))*TMPQ1
00243           IF (-3.0 .GT. ERFX(4)) IC3 = IC3+1
00245           IF (IC3 .GE. 2) GO TO 175
00247           ERFX(1) = (-S2-Z(M)+ZZL(K))*TMPQ1
00250           ERFX(2) = (-S2+Z(M+1)-ZZL(K))*TMPQ1
00251           ERFX(3) = (-S2+2.0*Z(IBOT)-Z(M)-ZZL(K))*TMPQ1
00252           CALL ISO(1,4)
00253           IC2 = IC2+1
00254           DO 170 MS=1,4
00257       170 STO2 = STO2+ERFX(MS)
00261           GO TO 165
00262       175 STO3 = 1.0
```

```
00263    105*            IF (IC1 .EQ. IC2) GO TO 185                                    BRK10200
00265    106*            IF (IC1 .GT. IC2) STO2 = STO2-4.0*FLOAT(IC1-IC2)               BRK10300
00267    107*            IF (IC1 .LT. IC2) STO2 = STO2+4.0*FLOAT(IC2-IC1)               BRK10400
00271    108*        185 CONTINUE                                                       BRK10500
00272    109*            IF (IZMOD(M) .EQ. 3) STO3 = 1.0/(Z(M+1)-Z(M))                  BRK10600
00274    110*            XBARX = EXP(-.5*(Y/SIGYNK)**2)                                 BRK10700
00275    111*        190 TMPQ2 = X/UBAR(JF)                                             BRK10800
00276    112*            S1 = (G(M)*STO3 /(2.0*SQR2P*UBAR(JF)*SIGYNK))*XBARX*STO2       BRK10900
00277    113*            IF (ISKIP(6) .EQ. 1) S1 = S1*EXP(-DECAY*TMPQ2)                 BRK11000
00301    114*            IF (ISKIP(7).LE.1.OR.ISKIP(7).EQ.3.OR.TIM1.GE.TMPQ2+TAST(ILK-1))  BRK11100
00301    115*           1GO TO 195                                                      BRK11200
00303    116*            IF (Z(M) .GT. ZLIM) GO TO 195                                  BRK11300
00305    117*            S1 = S1*EXP(-LAMBDA*(TMPQ2+TAST(ILK-1)-TIM1))                  BRK11400
00306    118*        195 CONTINUE                                                       BRK11500
00307    119*            S2 = (S1*UBAR(JF)/(SQR2P*SIGXNK))                              BRK11600
00310    120*            DOS(J) = DOS(J)+S1                                             BRK11700
00311    121*            CON(J) = CON(J)+S2                                             BRK11800
00312    122*        200 CONTINUE                                                       BRK11900
00314    123*            ANG(1) = UBAR(JF)                                              BRK12000
00315    124*            ANG(2) = SIGXNK                                                BRK12100
00316    125*        310 CONTINUE                                                       BRK12200
00317    126*            ERFX(1) = ANG(1)*TIMAV/(2.8284271*ANG(2))                      BRK12300
00320    127*            CALL ISO(1,1)                                                  BRK12400
00321    128*            AVCON(J) = (DOS(J)/TIMAV)*ERFX(1)                              BRK12500
00322    129*            PASSTM(J) = 4.3*ANG(2)/ANG(1)                                  BRK12600
00323    130*            AVMXCN(J) = DOS(J)/PASSTM(J)                                   BRK12700
00324    131*            IF (DOS(J) .GT. 0.0) GO TO 311                                 BRK12800
00326    132*            PASSTM(J) = 0.0                                                BRK12900
00327    133*        311 CONTINUE                                                       BRK13000
00327    134*      C                 ** CALCULATE WASHOUT **                            BRK13100
00330    135*            IF (ISKIP(7).EQ.0.OR.ISKIP(7).EQ.2) GO TO 340                  BRK13200
00332    136*            IF (Z(KK)-ZZL(K)) 340,315,340                                  BRK13250
00335    137*        315 IF (Z(KK) .GT. ZLIM) GO TO 340                                 BRK13300
00337    138*             CALL WASHI(X,Y,ISW5,XO,YO,N,K)                                BRK13400
00340    139*        340 CONTINUE                                                       BRK13500
00341    140*            RETURN                                                         BRK13600
00342    141*            END                                                            BRK13700
```

END OF COMPILATION: NO DIAGNOSTICS.

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@FOR,US DEPOS
FOR 010L-03/14/73-21:37:19 (0,1)

   SUBROUTINE DEPOS      ENTRY POINT 001062

   STORAGE USED: CODE(1) 001102; DATA(0) 000431; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003    PARAMT 002173
    0004    PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005    SGP
    0006    DEARS
    0007    BETAK
    0010    COORD
    0011    DEPSO
    0012    NWDU$
    0013    NI02$
    0014    NEXP6$
    0015    NI01$
    0016    SQRT
    0017    SIN
    0020    COS
    0021    EXP
    0022    NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001   000026 115G     0001   000174 12L      0001   000140 204G     0001   000163 217G     0001   000206 230G
    0001   000207 233G     0001   000254 251G     0001   000264 256G     0001   000323 271G     0001   000353 277G
    0001   000421 322G     0001   000376 35L      0001   000547 355G     0001   000625 370G     0001   000637 373G
    0001   000413 40L      0001   000667 401G     0001   000776 430G     0001   001605 435G     0001   001021 445G
    0001   000415 45L      0001   001022 450G     0001   000536 50L      0001   000543 55L      0001   000057 7L
    0001   000743 70L      0001   000745 71L      0001   000112 8L       0001   000125 9L       0000   000020 900F
    0000   000134 901F     0000   000157 902F     0000   000200 903F     0000   000216 904F     0000   000222 905F
    0000   000233 906F     0000   000310 907F     0000   000314 908F     0000   000344 909F     0003 R 001725 ACCUR
    0003 R 001056 ALPHA    0003   001777 ALPHL    0004   001510 ALPHNK   0004 R 001034 ANG      0000 R 000015 ASP
    0003 R 001114 BETA     0004   001344 BETANK   0003   002011 BFTL     0003   001605 CI       0004   000264 CON
    0003   000014 DATE     0003   001423 DECAY    0003 R 002172 DELPHI   0004 R 000074 DELTHP   0004   000226 DELU
    0003 R 000567 DELX     0003 R 000613 DELY     0004 R 000666 DEP      0004 R 001056 DEPN     0000 R 000011 DHK
    0003   001573 DI       0004 R 000455 DTHK     0003   000423 DXR      0003   001203 H        0003 R 001776 HB
    0004 I 000441 I        0004   000454 IBOT     0003   001427 IFLAG    0004 I 000665 II       0004   000450 ILK
    0000   000400 INJPS    0003 I 000016 ISKIP    0004   000502 ITAG     0004   000453 ITOP     0000 I 000012 IZ
    0003   001377 IZMOD    0004 I 000442 J        0003   001631 JROT     0004 I [illegible] JF   0003   001643 JTOP
    0004 I 000443 KK       0004 R 000437 L        0003 R 001426 LAMBDA   0004   025275 LAT      0004   000652 LB1
    0004   000057 LB2      0004 R 000651 MPWR     0000 I 000000 N        0003 I 000062 NBK      0003   000060 NCI
    0003   000057 NDI      0003   000061 NDXR     0004 I 000452 NNZ      0003   000063 NPTS     0000 I 000002 NTAP
    0000 I 000005 NTAK     0000 I 000003 NTAL     0000 I 000004 NTAP     0000 I 000006 NTAP     0003 I 000065 NVZ
    0003 I 000064 NVS      0004 I 001655 NXCI     0003 I 000054 NXS      0003 I 000055 NYS      0003 I 000056 NZS
    0004   000432 PEAKD    0003 R 001701 PERC     0003 R 001752 PERCB    0000 R 000017 PHI      0004   000647 PPW
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0003 R 000637 W         0004   000650 QPWR     0004 R 000451 RAD      0000 R 000007 S       0003 R 000710 SIGAK
0003   002052 SIGAL     0004 R C25444 SIGANK   0004 R 000636 SIGAP    0003 R 000735 SIGEK   0003   002076 SIGEL
0004 R 025300 SIGENK    0004   000132 SIGEP    0004   000435 SIGX     0004   000501 SIGXNK  0003   000762 SIGXO
0004   000434 SIGY      0004 R 025277 SIGYNK   0003 R 001006 SIGYO    0004   000433 SIGZ    0003 R 001032 SIGZO
0004 R 001654 SOBAR     0004   000436 SQR2P    0004 R 000444 STO1     0004   000445 STO2    0004   000446 STO3
0003 R 002146 T         0003   001617 TAST     0003 R 001201 TAUK     0003   002323 TAUL    0003 R 001202 TAUOK
0003   002024 TAUOL     0003 I 000000 TESTNO   0004 R 000440 TH       0000 R 000001 THET    0004 R 000170 THETA
0003 R 001154 THETAK    0003   002122 THETAL   0003   001153 TIMAV    0003   001425 TIM1    0004 R 000447 TRD
0004   000000 UBAR      0003 R 000663 UBARK    0003   002026 UBARL    0004   001200 UBARNK  0000 R 000010 UBHK
0003 R 001726 VD        0004   000430 VER      0004   000431 VREF     0003 R 001655 VS      0000 R 000013 X
0004   000455 XAST      0004   001033 XBARX    0003   001231 XLRY     0003   001232 XLRZ    0003   001227 XRY
0003   001230 XRZ       0000 R 000016 XS       0003 R 000066 XX       0000 R 000014 Y       0004   000667 YBARY
0003 R 000232 YY        0003 R 000376 Z        0003   001424 ZLIM     0003   001152 ZRK     0003   002025 ZRL
0003 R 001233 Z7L
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00101          SUBROUTINE DEPOS(NP)                                                     DPS00100
00103          COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI,        DPS00200
00103         1NDXR,NBK,NPTS,NVS,NVB,XX(100),YY(100),Z(21),DXR(100),DELX(20),           DPS00300
00103         2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20),        DPS00400
00103         3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)DPS00500
00103         4,XRY,XRZ,XLRY,XLRZ,Z7L(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,            DPS00600
00103         5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),             DPS00700
00103         6PERC(20),ACCUR,VD(20),PERCD(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL,       DPS00800
00103         7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI               DPS00900
00103          COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),DPS01000
00104         1DELU(30),CON(100),VER,VREF,PEAKD,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,DPS01100
00104         2STO1,STO2,STO3,TRD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)DPS01200
00104         3,JF,PPWR,QPWR,MPWR,LB1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),DPS01300
00104         4UBARNK(100),BETANK(100),ALPHNK(100),SOBAR,NXCI,DEPN(100,100),LAT,  DPS01400
00104         5SIGYNK,SIGENK(100),SIGANK(100)                                          DPS01500
00104   C      **** THIS SUBROUTINE CALCULATES GRAVITATIONAL DEPOSITION AT GROUNDDPS01600
00104   C                                                                              DPS01700
00104   C                                                                              DPS01800
00104          DIMENSION DTHK(21)                                                      DPS01900
00105          EQUIVALENCE (DTHK,XAST)                                                 DPS02000
00106          REAL MPWR,L,LAMBDA                                                      DPS02100
00107          INTEGER TESTNO                                                          DPS02200
00110   C                                                                              DPS02300
00110          WRITE (6,905)                                                           DPS02400
00111          NBK = 0                                                                 DPS02500
00113          DO 10 I=1,NNZ                                                           DPS02600
00114   C                      LIST INPUT PARAMETERS                                   DPS02700
00114          IF (I .GT. 1) GO TO 7                                                   DPS02800
00117          WRITE (6,900) I,UBARK(I),UBARK(I+1),SIGAK(I),SIGAK(I+1),SIGEK(I),  DPS02900
00121         1SIGEK(I+1),Q(I),DELX(I),DELY(I),SIGYO(I),SIGZO(I),ALPHA(I),BETA(I)DPS03000
00121         2,THETAK(I),TAUK,TAUOK,T(I),DELPHI,Z(I),THETAK(I+1)                     DPS03100
00121          GO TO 8                                                                 DPS03200
00150        7 CONTINUE                                                                DPS03300
00151          WRITE (6,906) I,UBARK(I+1),SIGAK(I+1),SIGEK(I+1),Q(I),DELX(I),       DPS03400
00152         1DELY(I),SIGYO(I),SIGZO(I),ALPHA(I),BETA(I),T(I),Z(I),THETAK(I+1)       DPS03500
00152        8 IF (I .LT. NNZ) GO TO 9                                                DPS03600
00172          WRITE (6,907) Z(I+1)                                                    DPS03700
00174        9 SIGAP(I) = SIGAK(I)*(TAUK/TAUOK)**(0.2)                                 DPS03800
00177       10 CONTINUE                                                                DPS03900
00200
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00202          WRITE (6,901) (I,VS(I),I,PERC(I),I=1,NVS)                   DPS04000
00213          IF (ISKIP(1) .NE. 2) GO TO 12                                DPS04100
00215          WRITE (6,908) (I,VB(I),I,PLRCB(I),I=1,NVS)                   DPS04200
00226       12 CONTINUE                                                     DPS04300
00227          DO 15 N=1,NYS                                                DPS04400
00232          DO 15 I=1,NXS                                                DPS04500
00235       15 DEPN(I,N) = 0.0                                              DPS04600
00240          THETA(1) = THETAK(1)                                         DPS04700
00241          TH = THETA(1)*RAD                                            DPS04800
00242          TRD = .5*DELPHI*RAD                                          DPS04900
00243          IF (THETA(1) .LT. 180.0) THET = (THETA(1)+180.0)*RAD         DPS05000
00245          IF (THETA(1) .GE. 180.0) THET = (THETA(1)-180.0)*RAD         DPS05100
00247          DTHK(1) = 0.0                                                DPS05200
00250          DO 20 N=2,NZS                                                DPS05300
00253       20 DTHK(N) = DTHK(N-1)+DELTHP(N-1)                              DPS05400
00255          DO 25 N=2,NZS                                                DPS05500
00260       25 DTHK(N) = DTHK(N)*RAD                                        DPS05600
00262          NTAD = 1                                                     DPS05700
00263          NTAL = 1                                                     DPS05800
00264          IF (ISKIP(1) .EQ. 2) NTAD = 2                                DPS05900
00266          IF (ISKIP(1) .EQ. 1.AND. NNZ .EQ. 1) NTAL = 2                DPS06000
00270          DO 73 JF=NTAL,NTAD                                           DPS06100
00273          NTAP = NVS                                                   DPS06200
00274          IF (JF .EQ. 2) NTAP = NVB                                    DPS06300
00276          DO 73 II=1,NTAP                                              DPS06400
00301          IF (JF .EQ. 2.OR.VS(II) .LE. 10.0) GO TO 35                  DPS06500
00303          WRITE (6,903) VS(II)                                         DPS06600
00306          RETURN                                                       DPS06700
00307       35 CONTINUE                                                     DPS06800
00310          NTAK = 1                                                     DPS06900
00311          NTAR = NNZ                                                   DPS07000
00312          IF (ISKIP(1) .NE. 2) GO TO 45                                DPS07100
00314          IF (JF .EQ. 2) GO TO 40                                      DPS07200
00316          NTAR = NTAR-1                                                DPS07300
00317          GO TO 45                                                     DPS07400
00320       40 NTAK = NNZ                                                   DPS07500
00321       45 DO 72 KK=NTAK,NTAR                                           DPS07600
00324          IF (JF .EQ. 2) GO TO 50                                      DPS07700
00326          S = ((Z(KK+1)-Z(KK))*.3333333)+Z(KK)                         DPS07800
00327          CALL SGP(S,KK,SIGENK(1),1)                                   DPS07900
00330          CALL UBARS(S,KK,1,UBHK)                                      DPS08000
00330   C      DETERMINE NO. SOURCES IN LINE SOURCE SIMULATION              DPS08100
00331          DHK = ACCUR*SIGENK(1)*SOBAR*SQRT(1.0+VS(II)/UBHK)            DPS08200
00332          IF (DHK .LT. 10.0) DHK = 10.0                                DPS08300
00334          S = (Z(KK+1)-Z(KK))/DHK                                      DPS08400
00335          NXCI = S+1.0                                                 DPS08500
00336          IF (NXCI .LT. 3) NXCI = 3                                    DPS08600
00340          IF (JF .EQ. 1) WRITE (6,909) VS(II),KK,NXCI                  DPS08700
00346          DHK = (Z(KK+1)-Z(KK))/FLOAT(NXCI)                            DPS08800
00347          STO1 = Z(KK)                                                 DPS08900
00350          GO TO 55                                                     DPS09000
00351       50 NXCI = 1                                                     DPS09100
00352          STO1 = 0.0                                                   DPS09200
00353          DHK = HB                                                     DPS09300
00354       55 DO 60 IZ=1,NXCI                                              DPS09400
00357          STO1 = STO1+DHK                                              DPS09500
00360          ZZL(IZ) = STO1                                               DPS09600
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00361          CALL SGP(ZZL(IZ),KK,SIGENK(IZ),1)                              DPS09700
00362          CALL SGP(ZZL(IZ),KK,SIGANK(IZ),2)                              DPS09800
00363          CALL UBARS(ZZL(IZ),KK,IZ,UBHK)                                 DPS09900
00364          CALL BETAK(ZZL(IZ),KK,IZ)                                      DPS10000
00365       60 CONTINUE                                                       DPS10100
00367          DO 71 I=1,NXS                                                  DPS10200
00372          DO 71 J=1,NYS                                                  DPS10300
00375          CALL COORD(N,1,X,Y,XX(I),YY(J),ASP,XS,1)                       DPS10400
00376          IF (N .EQ. 9) GO TO 71                                         DPS10500
00400          DO 70 IZ=1,NXCI                                                DPS10600
00403          PHI = ABS(ASP-(THET+ANG(IZ)))                                  DPS10700
00404          IF (PHI .GT. 3.1415926536) PHI = 6.2831853072-PHI              DPS10800
00406          Y =XS*SIN(PHI)                                                 DPS10900
00407          X =XS*COS(PHI)                                                 DPS11000
00410          IF (X .LT. 0.0) GO TO 70                                       DPS11100
00412          CALL DEPSO(X,KK,IZ)                                            DPS11200
00413          DEP = DEP*EXP(-.5*(Y/SIGYNK)**2)                               DPS11300
00414          DEPN(I,J) = DEPN(I,J)+DEP                                      DPS11400
00415       70 CONTINUE                                                       DPS11500
00417       71 CONTINUE                                                       DPS11600
00422       72 CONTINUE                                                       DPS11700
00424       73 CONTINUE                                                       DPS11800
00427          DO 75 I=1,NXS                                                  DPS11900
00432          WRITE (6,902) XX(I),(YY(J),DEPN(I,J),J=1,NYS)                  DPS12000
00442       75 CONTINUE                                                       DPS12100
00442    C                                                                    DPS12200
00444          DO 90 I=1,NXS                                                  DPS12300
00447          DO 90 J=1,NYS                                                  DPS12400
00452          DEPN(I,J) = 0.0                                                DPS12500
00453       90 CONTINUE                                                       DPS12600
00456          WRITE (6,904)                                                  DPS12700
00460          RETURN                                                         DPS12800
00461      900 FORMAT ('0','*** DATA INPUTS LAYER ',I2,', UBARK AT BOTTOM=',F8.4,DPS12900
00461         1', UBARK AT TOP=',F8.4,', SIGAK AT BOTTOM=',F8.5,', SIGAK AT TOP='DPS13000
00461         2,F8.5/' SIGEK AT BOTTOM=',F8.5,', SIGEK AT TOP=',F8.5,', Q=',E14.8DPS13100
00461         3,', DELX=',E14.8,', DELY=',E14.8/' SIGYO=',F9.4,', SIGZO=',F9.4,',DPS13200
00461         4 ALPHA=',F4.2,', BETA=',F4.2,', THETAK AT BOTTOM=',F8.4,', TAUK=',DPS13300
00461         5F8.3,', TAUOK=',F8.3/' T=',E14.8,', DELPHI=',F8.4,', Z=',F9.3,', TDPS13400
00461         6HETAK AT TOP=',F8.4)                                           DPS13500
00462      901 FORMAT (1H0,3(3HVS(,I2,2H)=,F10.5,7H, PERC(,I2,2H)=,F10.5,2H, )/(1DPS13600
00462         1X,3(3HVS(,I2,2H)=,F10.5,7H, PERC(,I2,2H)=,F10.5,2H, )))         DPS13700
00463      902 FORMAT (1H0,6X,3H X=,F10.2,3(5H **Y=,F10.2,6H, DEP=,E14.8,1H )/(20DPS13800
00463         1X,3(5H **Y=,F10.2,6H, DEP=,E14.8,1H )))                         DPS13900
00464      903 FORMAT (1H0,67H****** ERROR ****** VS HAS EXCEEDED MAXIMUM ALLOWAHDPS14000
00464         1LE VALUE 10, VS=,F9.4)                                          DPS14100
00465      904 FORMAT (12X,18(6H------)/)                                     DPS14200
00466      905 FORMAT (1H1,48X,36H***** GRAVITATIONAL DEPOSITION *****)       DPS14300
00467      906 FORMAT ('0 LAYER ',I2,', UBARK AT TOP=',F8.4,', SIGAK AT TOP=',F8.DPS14400
00467         15,', SIGEK AT TOP=',F8.5,', Q=',E14.8,', DELX=',E14.8/' DELY=',E14DPS14500
00467         2.8,', SIGYO=',F9.4,', SIGZO=',F9.4,', ALPHA=',F4.2,', BETA=',F4.2,DPS14600
00467         3', T=',E14.8,', Z=',F9.3/' THETAK AT TOP=',F8.4)                DPS14700
00470      907 FORMAT (1X,10H Z AT TOP=,F10.4)                                DPS14800
00471      908 FORMAT (1X,19HHEIGHT OF BURST FB=,F10.4,3HVB(,I2,2H)=,F10.5,8H, PEDPS14900
00471         1RCB(,I2,2H)=,F10.5,2H, /(1X,3(3HVB(,I2,2H)=,F10.5,6H, PERCB(,I2,2HDPS15000
00471         2)=,F10.5,2H, )))                                                DPS15100
00472      909 FORMAT ('0',10X,'VS =',F8.4,', LAYER NO. ',I2,', NO. OF SOURCES ='DPS15200
00472         1,I6)                                                            DPS15300
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00473    154*          END                                          DPS15400

      END OF COMPILATION:        NO  DIAGNOSTICS.
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BFOR,US CENTRL
FOR 010L-03/14/73-21:37:22 (0,1)

   SUBROUTINE CENTRL     ENTRY POINT 000363

   STORAGE USED: CODE(1) 000373; DATA(0) 000174; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003    PARAMT 002173
    0004    PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005    EL
    0006    SIGMA
    0007    PEAK
    0010    VERT
    0011    ISO
    0012    NWDU$
    0013    N102$
    0014    EXP
    0015    NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001     000236 100L      0001     000014 115G      0001     000060 135G      0001     000054 20L       0001     000305 211G
    0001     000336 400L      0001     000341 410L      0001     000203 60L       0000     000003 900F      0000     000031 901F
    0000     000046 905F      0000     000052 906F      0000     000064 907F      0000     000192 908F      0000     000134 909F
    0003     001725 ACCUR     0003     001056 ALPHA     0003     001777 ALPHL     0004     001510 ALPHNK    0004     001034 ANG
    0004 R 001344 AVCON     0004 R 001200 AVMXCN    0003     001114 BETA      0004     001344 BETANK    0003     002011 BETL
    0003     001605 CI        0004 R 000264 CON       0003     000014 DATE      0003 R 001423 DECAY     0003     002172 DELPHI
    0004     000074 DELTHP    0004     000226 DELU      0003     000567 DFLX      0003     000613 DELY      0004     000666 DEP
    0004     001656 DEPN      0003     001573 DI        0004 R 000667 DOS       0003 R 000423 DXR       0003 R 001726 ERFX
    0003     001203 H         0003     001776 HB        0004 I 000441 I         0004     000454 IBOT      0003     001427 IFLAG
    0004     000665 II        0004     000450 ILK       0000     000156 INJP$     0003 I 000016 ISKIP     0004     000502 ITAG
    0004     000453 ITOP      0003 I 001377 IZMOD     0004 I 000442 J         0003     001631 JBOT      0004     000646 JF
    0003     001643 JTOP      0000 I 000000 K         0004 I 000443 KK        0004 R 000437 L         0003 R 001426 LAMBDA
    0004     025276 LAT       0004     000652 LB1       0004     000657 LB2       0004 R 000651 MPWR      0003     000062 NBK
    0003     000060 NCI       0003     000057 NDI       0003 I 000061 NOXR      0004 I 000452 NNZ       0003 I 000063 NPTS
    0003     000065 NVB       0003     000064 NVS       0004     001655 NXCI      0003     000054 NXS       0003     000055 NYS
    0003     000056 NZS       0004 R 001510 PASSTM    0004     000432 PEAKD     0003     001701 PERC      0003     001752 PERCB
    0004     000047 PPWR      0003     000637 Q         0004     000650 QPWR      0004 R 000451 RAD       0003     000710 SIGAK
    0003     002052 SIGAL     0004     025444 SIGANK    0004     000036 SIGAP     0003     000735 SIGEK     0003     002076 SIGFL
    0004     025300 SIGENK    0004     000132 SIGEP     0004 R 000435 SIGX      0004     000301 SIGXNK    0003     000762 SIGXO
    0004 R 000434 SIGY      0004     025277 SIGYNK    0003     001036 SIGYO     0004 R 000433 SIGZ      0003     001032 SIGZO
    0004     001654 SUBAR     0004 R 000436 SQR2P     0004 R 000444 STO1      0004 R 000445 STO2      0004 R 000446 STO3
    0003     002146 T         0003     001617 TAST      0003     001201 TAUK      0003     002023 TAUL      0003     001202 TAUOK
    0003     002024 TAUOL     0003 I 000000 TESTNO    0004 R 000440 TH        0004 R 000170 THETA     0003     001154 THETAK
    0003     002122 THETAL    0003 R 001153 TIMAV     0003 R 001425 TIM1      0000 R 000202 THPQ1     0004     000447 TRD
    0004 R 000000 UBAR      0003     000663 UBARK     0003     002026 UBARL     0004     001200 UBARNK    0003     001726 VB
    0004     000430 VER       0004     000431 VREF      0003     001655 VS        0004     000455 XAST      0004     001033 XBARX
    0003     001231 XLRY      0003     001232 XLRZ      0003     001227 XPY       0003     001230 XRZ       0003     000066 XX
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    0004   000667 YBARY      0000 R 000001 YO        0003    000232 YY        0003 R 000376 Z           0003 R 001424 ZLIM
    0003   001152 ZRK        0003    002025 ZRL      0003 R 001233 ZZL

00101             SUBROUTINE CENTRL                                                  CTL00100
00103             COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI,  CTL00200
00103            1NDXR,NBK,NPTS,NVS,NVB,XX(100),YY(100),Z(21),DXR(100),DELX(20),     CTL00300
00103            2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20),  CTL00400
00103            3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)CTL00500
00103            4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,      CTL00600
00103            5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),        CTL00700
00103            6PERC(20),ACCUR,VB(20),PERCB(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL,  CTL00800
00103            7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI          CTL00900
00104             COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),CTL01000
00104            1DELU(30),CON(100),VER,VREF,PEAKD,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,CTL01100
00104            2STO1,STO2,STO3,TRD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)CTL01200
00104            3,JF,PPWR,QPWR,MPWR,LB1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),CTL01300
00104            4UBARNK(100),BETANK(100),ALPHNK(100),SQBAR,NXCI,DEPN(100,100),LAT,  CTL01400
00104            5SIGYNK,SIGENK(100),SIGANK(100)                                     CTL01500
00105             DIMENSION DOS(100),ERFX(6),AVCON(100),PASSTM(100),AVMXCN(100)      CTL01600
00106             EQUIVALENCE (DOS,YBARY),(ANG(10),ERFX),(AVCON,BETANK),             CTL01700
00106            1(PASSTM,ALPHNK),(AVMXCN,UBARNK)                                    CTL01800
00107             INTEGER TESTNO                                                     CTL01900
00110             REAL MPWR,L,LAMBDA                                                 CTL02000
00110       C     **** THIS SUBROUTINE CALCULATES PEAK DOSAGE AND PEAK CONCENTRATIONCTL02100
00110       C     **** AT RADIAL DISTANCES DXR ALONG THE CLOUD AXIS.                 CTL02200
00110       C     **** ISKIP(19)                                                     CTL02300
00110       C     **** CONTROLS THE PLOTTING OF PEAK DOSAGE AND PEAK CONCENTRATION   CTL02400
00110       C     **** VS. DXR.                                                      CTL02500
00111             WRITE (6,907)                                                      CTL02600
00113             K = 1                                                              CTL02700
00114             DO 400 KK=1,NNZ                                                    CTL02800
00117             IF (K .GT. NPTS) GO TO 410                                         CTL02900
00121             IF (ZZL(K)-Z(KK+1)) 10,400,400                                     CTL03000
00124          10 CONTINUE                                                           CTL03100
00125             TH = RAD*THETA(KK)                                                 CTL03200
00126             J = 1                                                              CTL03300
00127             IF (THETA(KK) .LT. 180.0) YO = THETA(KK)+180.0                     CTL03400
00131             IF (THETA(KK) .GE. 180.0) YO = THETA(KK)-180.0                     CTL03500
00133          20 CONTINUE                                                           CTL03600
00134             DO 100 I=1,NDXR                                                    CTL03700
00134       C                   ***** CALCULATION SECTION *****                      CTL03800
00137             CALL EL(DXR(I),0)                                                  CTL03900
00140             CALL SIGMA(DXR(I),0,0)                                             CTL04000
00141             IF (SIGY) 100,100,30                                               CTL04050
00144          30 IF (SIGZ .LE. 0.0.AND.IZMOD(KK) .EQ. 3) GO TO 100                  CTL04060
00146             CALL PEAK(2,K)                                                     CTL04100
00147             CALL VERT(K,2)                                                     CTL04200
00150             TMPQ1 = DXR(I)/UBAR(KK)                                            CTL04300
00151             DOS(I) = STO1*(STO2+STO3)                                          CTL04400
00152             IF (ISKIP(6) .EQ. 1) DOS(I) = DOS(I)*EXP(-DECAY*TMPQ1)             CTL04500
00154             IF (ISKIP(7) .NE. 2.OR.TIM1 .GE. TMPQ1) GO TO 80                   CTL04600
00156             IF (Z(KK) .GT. ZLIM) GO TO 80                                      CTL04700
00160             DOS(I) = DOS(I)*EXP(-LAMBDA*(TMPQ1-TIM1))                          CTL04800
00161          80 CONTINUE                                                           CTL04900
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00162            ERFX(1) = UBAR(KK)*TIMAV/(2.8284271*SIGX)                    CTL05000
00163            CALL ISO(1,1)                                                CTL05100
00164            AVCON(I) = (DOS(I)/TIMAV)*ERFX(1)                            CTL05200
00165            PASSTM(I) = 4.3*SIGX/UBAR(KK)                                CTL05300
00166            AVMXCN(I) = DOS(I)/PASSTM(I)                                 CTL05400
00167         90 CONTINUE                                                     CTL05500
00170            CON(I) = DOS(I)*UBAR(KK)/(SQR2P*SIGX)                        CTL05600
00171        100 CONTINUE                                                     CTL05700
00171      C                *** SOLUTION OUTPUT SECTION ***                   CTL05800
00173            WRITE (6,900) KK,ZZL(K),YO                                   CTL05900
00200            IF (ISKIP(6) .EQ. 1) WRITE (6,906)                           CTL06000
00203            IF (ISKIP(7) .EQ. 2) WRITE (6,901)                           CTL06100
00206        110 WRITE (6,908)                                                CTL06300
00210            DO 115 I=1,NDXR                                              CTL06400
00213        115 WRITE (6,909) DXR(I),DOS(I),CON(I),AVCON(I),PASSTM(I),AVMXCN(I)  CTL06500
00213      C                                                                  CTL06600
00224        380 K = K+1                                                      CTL06700
00225            IF (K .GT. NPTS) GO TO 410                                   CTL06800
00227            IF (ZZL(K) .LT. Z(KK+1)) GO TO 20                            CTL06900
00231        400 CONTINUE                                                     CTL07000
00233        410 WRITE (6,905)                                                CTL07100
00235            RETURN                                                       CTL07200
00236        900 FORMAT ('0',12X,'* CALCULATIONS FOR LAYER',I3,', AT HEIGHT ',F10.3CTL07300
00236           1,' WITH CLOUD AXIS AT ',F8.3,' DEGREES RELATIVE TO SOURCE *'/)  CTL07400
00237        901 FORMAT (33X,' PRECIPITATION SCAVENGING IS INCLUDED IN DOSAGE, CONCCTL07500
00237           1ENTRATION, ETC'/)                                            CTL07600
00240        905 FORMAT (12X,18(6H------)/)                                   CTL07900
00241        906 FORMAT (41X,49H* DECAY IS INCLUDED IN DOSAGE, CONCENTRATION, ETC) CTL08000
00242        907 FORMAT ('1',33X,'*-* MAXIMUM CENTERLINE CONCENTRATION, CENTERLINE CTL08100
00242           1DOSAGE, ETC *-*'/)                                           CTL08200
00243        908 FORMAT (54X,'TIME MEAN',37X,'AVERAGE'/' RADIAL DISTANCE   DOSAGE  CTL08300
00243           1      CONCENTRATION   ALONGWIND CONCENTRATION  TIME OF PASSAGE   ACTL08400
00243           2LONGWIND CONCENTPATION')                                     CTL08500
00244        909 FORMAT (1X,F10.3,5X,E14.8,2X,E14.8,6X,E14.8,9X,E14.8,6X,E14.8)  CTL08550
00245            END                                                          CTL08600

END OF COMPILATION:        NO  DIAGNOSTICS.
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NASA/MSFC MULTILAYER DIFFUSION MODEL, VERSION 2  H E CRAMER CO                        DATE 031473        PAGE    35

@FOR,US ISOXY
FOR 010L-03/14/73-21:37:25 (0,1)

   SUBROUTINE ISOXY      ENTRY POINT 000642

   STORAGE USED: CODE(1) 000662; DATA(0) 000240; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003    PARAMT 002173
    0004    PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005    EL
    0006    SIGMA
    0007    PEAK
    0010    VERT
    0011    NWDU$
    0012    NI02$
    0013    EXP
    0014    ALOG
    0015    SQRT
    0016    NI01$
    0017    NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001    000037 123G     0001    000105 144G     0001    000116 153G     0001    000147 170G     0001    000103 20L
    0001    000334 223G     0001    000377 240G     0001    000500 264G     0001    000507 271G     0001    000547 304G
    0001    000556 511G     0001    000136 50L      0001    000362 530L     0001    000421 535L     0001    000422 536L
    0001    000425 540L     0001    000521 570L     0001    000570 590L     0001    000142 60L      0001    000274 62L
    0001    000573 620L     0001    000605 630L     0001    000610 640L     0001    000356 65L      0001    000357 66L
    0000    000005 906F     0000    000027 907F     0000    000035 908F     0000    000043 909F     0000    000070 910F
    0000    000104 911F     0000    000113 912F     0000    000117 913F     0000    000140 919F     0000    000155 920F
    0003    001725 ACCUR    0003    001056 ALPHA    0003    001777 ALPHL    0004    001510 ALPHNK   0004    001034 ANG
    0000 R  000004 B        0003    001114 BETA     0004    001344 BETANK   0003    002011 BETL     0003 R  001605 CI
    0004 R  000264 CON      0003    000014 DATE     0003 R  001423 DECAY    0003    002172 DELPHI   0004    000074 DELTHP
    0004    000226 DELU     0003    000567 DELX     0003    000613 DELY     0004    000566 DEP      0004    001656 DEPN
    0003 R  001573 DI       0004 R  000667 DOS      0003 R  000423 DXR      0003    001203 H        0003    001776 HH
    0004 I  000441 I        0004    000454 IBOT     0003    001427 IFLAG    0004    000665 II       0004    000450 ILK
    0000    000203 INJP$    0003 I  000016 ISKIP    0004    000502 ITAG     0004    000453 ITOP     0003 I  001377 IZMOD
    0004 I  000442 J        0003    001631 JBOT     0004    000646 JF       0003    001643 JTOP     0000 I  000000 K
    0004 I  000443 KK       0004 R  000437 L        0003 R  001426 LAMBDA   0004    025276 LAT      0004    000652 LB1
    0004    000657 LB2      0004 R  000651 MPWR     0000 I  000002 N        0003    000062 NBK      0003 I  000060 NCI
    0003 I  000057 NUI      0003 I  000061 NDXR     0004 I  000452 NNZ      0003 I  000063 NPTS     0003    000065 NVB
    0003    000064 NVS      0004    001655 NXCI     0003    000054 NXS      0003    000055 NYS      0003    000056 NZS
    0004    000432 PEAKD    0003    001761 PERC     0003    001752 PERCB    0004 R  001656 PLT      0004    000647 PPWR
    0003    000037 Q        0004    000650 QPWR     0004 R  000451 RAD      0000 R  000001 S        0003    000710 SIGAK
    0003    002052 SIGAL    0004    025444 SIGANK   0004    000025 SIGAP    0003    000735 SIGEK    0003    002076 SIGEL
    0004    025300 SIGENK   0004    000132 SIGEP    0004 R  000435 SIGX     0004    000501 SIGXNK   0003    000762 SIGXO
    0004 R  000434 SIGY     0004    025277 SIGYNK   0003    001006 SIGYO    0004 R  000433 SIGZ     0003    001032 SIGZO
    0004    001654 SQBAR    0004 R  000436 SQR2P    0004 R  000444 STO1     0004 R  000445 STO2     0004 R  000446 STO3
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NASA/MSFC MULTILAYER DIFFUSION MODEL, VERSION 2  H E CRAMER CO                                  DATE 031473        PAGE-    36

 0003     002146 T            0003    001617 TAST      0003    001201 TAUK     0003    002023 TAUL      0003    001202 TAUOK
 0003     002024 TAUOL        0003 I 000000 TESTNO     0004 R 000440 TH        0004 R 000170 THETA     0003    001154 THETAK
 0003     002122 THETAL       0003    001153 TIMAV     0003 R 001425 TIM1      0000 R 000003 TMPQ1     0004    000447 TRD
 0004 R 000000 UBAR           0003    000663 UBARK     0003    002026 UBARL    0004    001200 UBARNK    0003    001726 VB
 0004     000430 VER          0004    000431 VREF      0003    001655 VS       0004    000455 XAST      0004    001033 XBARX
 0003     001231 XLRY         0003    001232 XLRZ      0003    001227 XRY      0003    001230 XRZ       0003    000066 XX
 0004     000667 YBARY        0003    000232 YY        0003 R 000376 Z         0003 R 001424 ZLIM      0003    001152 ZRK
 0003     002025 ZRL          0003 R 001233 ZZL


00101      1*          SUBROUTINE ISOXY                                                          IXY00100
00103      2*          COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI,        IXY00200
00103      3*         1NDXR,NBK,NPTS,NVS,NVR,XX(100),YY(100),Z(21),DXR(100),DELX(20),           IXY00300
00103      4*         2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20),        IXY00400
00103      5*         3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)IXY00500
00103      6*         4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,           IXY00600
00103      7*         5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),             IXY00700
00103      8*         6PERC(20),ACCUR,VB(20),PERCB(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL,        IXY00800
00103      9*         7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI               IXY00900
00104     10*          COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),IXY01000
00104     11*         1DELU(30),CON(100),VEP,VREF,PEAKD,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,IXY01100
00104     12*         2STO1,STO2,STO3,TRD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)IXY01200
00104     13*         3,JF,PPWR,GPWR,MPWR,LB1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),IXY01300
00104     14*         4UBARNK(100),BETANK(100),ALPHNK(100),SOBAR,NXCI,DEPN(100,100),LAT,  IXY01400
00104     15*         5SIGYNK,SIGLNK(100),SIGANK(100)                                           IXY01500
00105     16*          DIMENSION DOS(100),PLT(2,100,10)                                         IXY01600
00106     17*          EQUIVALENCE (DOS,YBARY),(PLT,DEPN)                                       IXY01700
00107     18*          INTEGER TESTNO                                                            IXY01800
00110     19*          REAL MPWR,L,LAMBDA                                                        IXY01900
00110     20*    C     **** THIS SUBROUTINE CALCULATES DOSAGE AND CONCENTRATION ISOPLETHSIXY02000
00110     21*    C     **** IN THE X,Y PLANE AROUND THE CLOUD AXIS. THE ISOPLETH PRODUCEDIXY02100
00110     22*    C     **** IS THE LATERAL DISTANCE FROM THE CLOUD AXIS. ISKIP(4)            IXY02200
00110     23*    C     **** CONTROLS AT WHICH HEIGHTS ISOPLETHS ARE CALCULATED)               IXY02300
00111     24*          WRITE (6,909)                                                             IXY02400
00113     25*          IF (ISKIP(6) .EQ. 1) WRITE (6,913)                                        IXY02500
00116     26*          IF (ISKIP(7) .EQ. 2) WRITE (6,906)                                        IXY02600
00121     27*          K = 1                                                                     IXY02700
00122     28*          DO 630 KK=1,NNZ                                                           IXY02800
00125     29*          IF (K .GT. NPTS) GO TO 640                                                IXY02900
00127     30*          IF (ZZL(K)-Z(KK+1)) 10,630,630                                            IXY03000
00132     31*       10 CONTINUE                                                                  IXY03100
00133     32*          TH = RAD*THETA(KK)                                                        IXY03200
00134     33*          IF (THETA(KK) .GE. 180.0) S = THETA(KK)-180.0                             IXY03300
00136     34*          IF (THETA(KK) .LT. 180.0) S = THETA(KK)+180.0                             IXY03400
00140     35*          WRITE (6,910) S                                                           IXY03500
00143     36*       20 DO 30 N=3,9,3                                                             IXY03600
00146     37*          IF (ISKIP(4) .EQ. N) GO TO 60                                             IXY03700
00150     38*       30 CONTINUE                                                                  IXY03800
00152     39*          DO 40 N=2,8,3                                                             IXY03900
00155     40*          IF (ISKIP(4) .EQ. N) GO TO 50                                             IXY04000
00157     41*       40 CONTINUE                                                                  IXY04100
00161     42*          IF (K .GT. 1) RETURN                                                      IXY04200
00163     43*          GO TO 60                                                                  IXY04300
00164     44*       50 IF (Z(KK)-ZZL(K)) 620,60,620                                              IXY04400
00164     45*    C                              CALCULATION SECTION                             IXY04500
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00167         60 DO 540 I=1,NDXR                                                       IXY04600
00172            J = 1                                                                 IXY04700
00173            CALL EL(DXR(I),0)                                                     IXY04800
00174            CALL SIGMA(DXR(I),0,0)                                                IXY04900
00175            IF (SIGY) 540,540,61                                                  IXY04950
00200         61 IF (SIGZ .LE. 0.0.AND.IZMOD(KK) .EQ. 3) GO TO 540                    IXY04960
00202            CALL PEAK(2,K)                                                        IXY05000
00203            CALL VERT(K,2)                                                        IXY05100
00204            TMPQ1 = DXR(I)/UBAR(KK)                                               IXY05200
00205            DOS(I) = SIO1*(STO2+STO3)                                             IXY05300
00206            IF (ISKIP(6) .EQ. 1) DOS(I) = DOS(I)*EXP(-DECAY*TMPQ1)               IXY05400
00210            IF (ISKIP(7) .NE. 2.OR.TIM1 .GE. TMPQ1) GO TO 62                      IXY05500
00212            IF (Z(KK) .GT. ZLIM) GO TO 62                                         IXY05600
00214            DOS(I) = DOS(I)*EXP(-LAMBDA*(TMPQ1-TIM1))                             IXY05700
00215         62 CONTINUE                                                              IXY05800
00216            CON(I) = DOS(I)*UBAR(KK)/(SQR2P*SIGX)                                 IXY05900
00217            TMPQ1 = 2.0*SIGY*SIGY                                                 IXY06000
00220            IF (ISKIP(4) .LE. 6.AND.ISKIP(4) .GE. 4) GO TO 530                    IXY06100
00222            DO 66 J=1,NDI                                                         IXY06200
00225            B = DOS(I)/DI(J)                                                      IXY06300
00226            IF (B .LE. 1.0) GO TO 65                                              IXY06400
00230            PLT(1,I,J) = SQRT(TMPQ1*ALOG(B))                                      IXY06500
00231            GO TO 66                                                              IXY06600
00232         65 PLT(1,I,J) = 0.0                                                      IXY06700
00233         66 CONTINUE                                                              IXY06800
00235        530 IF (ISKIP(4) .LE. 3) GO TO 540                                        IXY06900
00237            DO 536 J=1,NCI                                                        IXY07000
00242            B = CON(I)/CI(J)                                                      IXY07100
00243            IF (B .LE. 1.0) GO TO 535                                             IXY07200
00245            PLT(2,I,J) = SQRT(TMPQ1*ALOG(B))                                      IXY07300
00246            GO TO 536                                                             IXY07400
00247        535 PLT(2,I,J) = 0.0                                                      IXY07500
00250        536 CONTINUE                                                              IXY07600
00252        540 CONTINUE                                                              IXY07700
00254            WRITE (6,907) ZZL(K)                                                  IXY07800
00257            IF (ISKIP(4) .LE. 6.AND.ISKIP(4) .GE. 4) GO TO 570                    IXY07900
00257      C                        *****WRITE ISOPLETHS *****                         IXY08000
00261            WRITE (6,908)                                                         IXY08100
00263            DO 560 I=1,NDXR                                                       IXY08200
00266        560 WRITE (6,919)  DXR(I),(DI(J),PLT(1,I,J),J=1,NDI)                      IXY08300
00277        570 IF (ISKIP(4) .LE. 3) GO TO 590                                        IXY08400
00301            WRITE (6,911)                                                         IXY08500
00303            DO 580 I=1,NCXR                                                       IXY08600
00306        580 WRITE (6,920)  DXR(I),(CI(J),PLT(2,I,J),J=1,NCI)                      IXY08700
00317        590 CONTINUE                                                              IXY08800
00317      C                                                                           IXY08900
00320        620 CONTINUE                                                              IXY09000
00321            K = K+1                                                               IXY09100
00322            IF (K .GT. NPTS) GO TO 640                                            IXY09200
00324            IF (ZZL(K) .LT. Z(KK+1)) GO TO 20                                     IXY09300
00326        630 CONTINUE                                                              IXY09400
00330        640 WRITE (6,912)                                                         IXY09500
00332            RETURN                                                                IXY09600
00333        906 FORMAT (18X,' PRECIPITATION SCAVENGING HAS BEEN INCLUDED IN DOSAGEIXY09700
00333          1 AND CONCENTRATION IN CALCULATING ISOPLETHS')                          IXY09800
00334        907 FORMAT (1H ,54X,10H* HEIGHT =,F10.2,2H *)                              IXY09900
00335        908 FORMAT (1H ,54X,20H* DOSAGE ISOPLETHS *)                               IXY10000
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00336    103*      909 FORMAT (1H1,37X,56H***** ISOPLETHS HORIZONTAL PLANE AROUND CLOUD AIXY10100
00336    104*         1XIS *****/45X,43H** Y IS LATERAL DISTANCE FROM CLOUD AXIS **///)  IXY10200
00337    105*      910 FORMAT (30X,23H** ANGLE TO CLOUD AXIS=,F8.3,30H DEGREES RELATIVE TIXY10300
00337    106*         10 SOURCE **)                                                      IXY10400
00340    107*      911 FORMAT (1H ,53X,27H* CONCENTRATION ISOPLETHS *)                   IXY10500
00341    108*      912 FORMAT (12X,18(6H------)/)                                        IXY10600
00342    109*      913 FORMAT (22X,89H* THE DECAY TERM HAS BEEN INCLUDED IN DOSAGE AND COIXY10700
00342    110*         1NCENTRATION IN CALCULATING ISOPLETHS *)                           IXY10800
00343    111*      919 FORMAT (1H ,56X,18HRADIAL DISTANCE R=,F10.2/(9X,3(10H * DOSAGE=,E1IXY10900
00343    112*         14.8,4H, Y=,F10.2)))                                               IXY11000
00344    113*      920 FORMAT (1H ,56X,18HRADIAL DISTANCE R=,F10.2/(3(16H *CONCENTRATION=IXY11100
00344    114*         1,E14.8,4H, Y=,F10.2)))                                            IXY11200
00345    115*          END                                                               IXY11300

     END OF COMPILATION:       NO  DIAGNOSTICS.
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@FOR,US ISOYZ
FOR 010L-03/14/73-21:37:28 (0,1)

  SUBROUTINE ISOYZ      ENTRY POINT 000540

  STORAGE USED: CODE(1) 000554; DATA(0) 000225; BLANK COMMON(2) 000000

   COMMON BLOCKS:

   0003   PARAMT 002173
   0004   PARAMS 025610

  EXTERNAL REFERENCES (BLOCK, NAME)

   0005   EL
   0006   SIGMA
   0007   PEAK
   0010   VERT
   0011   NWDU$
   0012   NI02$
   0013   EXP
   0014   ALOG
   0015   SQRT
   0016   NI01$
   0017   NERR3$

  STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

   0001   000035 122G     0001   000050 131G     0001   000255 177G     0001   000103 20L      0001   000317 214G
   0001   000227 22L      0001   000277 24L      0001   000420 246G     0001   000427 253G     0001   000300 26L
   0001   000466 266G     0001   000475 273G     0001   000303 40L      0001   000341 42L      0001   000342 44L
   0001   000345 620L     0001   000362 670L     0001   000441 680L     0001   000507 690L     0001   000507 710L
   0000   000005 915F     0000   000031 916F     0000   000035 917F     0000   000044 918F     0000   000066 919F
   0000   000073 920F     0000   000077 921F     0000   000120 922F     0000   000142 925F     0003   001725 ACCUR
   0003   001056 ALPHA    0003   001777 ALPHL    0004   001510 ALPHNK   0004   001034 ANG      0000 R 000003 B
   0003   001114 BETA     0004   001344 BETANK   0003   002011 BETL     0003 R 001605 CI       0004 R 000264 CON
   0003   000014 DATE     0003 R 001423 DECAY    0003   002172 DELPHI   0004   000074 DELTHP   0004   000226 DELU
   0003   000567 DELX     0003   000613 DELY     0004   000666 DEP      0004   001656 DEPN     0003 R 001573 DI
   0004 R 000667 DOS      0003 R 002423 DXR      0003   001203 H        0003   001776 HB       0004 I 000441 I
   0004   000454 IBOT     0003 I 001427 IFLAG    0004   000665 II       0004   000450 ILK      0000   000176 INJP$
   0003 I 000016 ISKIP    0004   000502 ITAG     0004   000453 ITOP     0003 I 001377 IZMOD    0004 I 000442 J
   0003   001631 JBOT     0004   000646 JF       0003   001643 JTOP     0000 I 000000 K        0004 I 000443 KK
   0004 R 000437 L        0003 R 001426 LAMBDA   0004   025276 LAT      0004   000652 LB1      0004   000657 LB2
   0004 R 000651 MPWR     0000 I 000004 N        0003   000062 NBK      0003 I 000060 NCI      0003 I 000057 NDI
   0003 I 000061 NDXR     0004 I 000452 NNZ      0003 I 000063 NPTS     0003   000065 NVB      0003   000064 NVS
   0004   001655 NXCI     0003   000054 NXS      0003   000055 NYS      0003   000056 NZS      0004   000432 PEAKD
   0003   001701 PERC     0003   001752 PERCB    0004 R 001656 PLT      0004   000647 PPWR     0003   000637 Q
   0004   000650 OPWR     0004   000451 RAD      0000 R 000001 S        0003   000710 SIGAK    0003   002052 SIGAL
   0004   025444 SIGANK   0004   000026 SIGAP    0003   000735 SIGEK    0003   002076 SIGEL    0004   025300 SIGENK
   0004   000132 SIGEP    0004 R 000435 SIGX     0004   000501 SIGXNK   0003   000762 SIGXO    0004 R 000434 SIGY
   0004   025277 SIGYNK   0003   001006 SIGYO    0004 R 000433 SIGZ     0003   001032 SIGZO    0004   001654 SQBAR
   0004 R 000436 SQR2P    0004 R 000444 STO1     0004 R 000445 STO2     0004 R 000446 STO3     0003   002146 T
   0003   001617 TAST     0003   001201 TAUK     0003   002023 TAUL     0003   001202 TAUOK    0003   002024 TAUOL
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0003 I 000000 TESTNO    0004   000440 TH      0004 R 000170 THETA    0003   001154 THETAK   0003   002122 THETAL
0003   001153 TIMAV     0003 R 001425 TIM1    0000 R 000002 TMP01    0004   000447 TRD      0004 R 000000 UBAR
0003   000663 UBARK     0003   002026 UBARL   0004   001220 UBARNK   0003   001726 VB       0004   000430 VER
0004   000431 VREF      0003   001655 VS      0004   000455 XAST     0004   001033 XBARX    0003   001231 XLRY
0003   001232 XLRZ      0003   001227 XRY     0003   001230 XRZ      0003   000066 XX       0004   000667 YBARY
0003   000232 YY        0003 R 000376 Z       0003 R 001424 ZLIM     0003   001152 ZRK      0003   002025 ZRL
0003 R 001233 ZZL

00101           SUBROUTINE ISOYZ                                                  IYZ00100
00103           COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI, IYZ00200
00103          1NDXR,NBK,NPTS,NVS,NVB,XX(100),YY(100),Z(21),DXR(100),DELX(20),    IYZ00300
00103          2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20), IYZ00400
00103          3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THET K(21),TAUK,TAUOK,H(20)IYZ00500
00103          4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,     IYZ00600
00103          5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),       IYZ00700
00103          6PERC(20),ACCUR,VB(20),PERCB(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL, IYZ00800
00103          7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI         IYZ00900
00104           COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),IYZ01000
00104          1DELU(30),CON(100),VER,VREF,PEAKD,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,IYZ01100
00104          2ST01,ST02,ST03,TPD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)IYZ01200
00104          3,JF,PPWR,QPWR,MPWR,LP1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),IYZ01300
00104          4UBARNK(100),BETANK(100),ALPHNK(100),SOBAR,NXCI,DEPN(100,100),LAT, IYZ01400
00104          5SIGYNK,SIGENK(100),SIGANK(100)                                    IYZ01500
00105           DIMENSION DOS(100),PLT(2,100,10)                                  IYZ01600
00106           EQUIVALENCE (DOS,YBARY),(PLT,DEPN)                                IYZ01700
00107           INTEGER TESTNO                                                    IYZ01800
00110           REAL MPWR,L,LAMBDA                                                IYZ01900
00110     C     **** THIS SUBROUTINE CALCULATES DOSAGE AND CONCENTRATION ISOPLETHSIYZ02000
00110     C     **** IN THE Y,Z PLANE AROUND THE CLOUD AXIS. THE ISOPLETH PRODUCEDIYZ02100
00110     C     **** IS THE LATERAL DISTANCE FROM THE CLOUD AXIS. THE ARRAY IFLAG IYZ02200
00110     C     **** CONTROLS AT WHICH DISTANCES DXR ISOPLETHS WILL BE            IYZ02300
00110     C     **** CALCULATED                                                   IYZ02400
00111           WRITE (6,915)                                                     IYZ02500
00113           IF (ISKIP(6) .EQ. 1) WRITE (6,921)                                IYZ02600
00116           IF (ISKIP(7) .EQ. 2) WRITE (6,922)                                IYZ02700
00116     C                        CALCULATION SECTION                            IYZ02800
00121           DO 710 I=1,NDXR                                                   IYZ02900
00124           IF (IFLAG(I) .EQ. 0) GO TO 710                                    IYZ03000
00126           K = 1                                                             IYZ03100
00127           S = 0.0                                                           IYZ03200
00130           DO 670 KK=1,NNZ                                                   IYZ03300
00133           IF (K .GT. NPTS) GO TO 710                                        IYZ03400
00135           IF (ZZL(K)-Z(KK+1)) 10,670,670                                    IYZ03500
00140        10 CONTINUE                                                          IYZ03600
00141           IF (THETA(KK) .GE. 180.0) S = THETA(KK)-180.0                     IYZ03700
00143           IF (THETA(KK) .LT. 180.0) S = THETA(KK)+180.0                     IYZ03800
00145        20 CONTINUE                                                          IYZ03900
00146           J = 1                                                             IYZ04000
00147           CALL EL(DXR(I),0)                                                 IYZ04100
00150           CALL SIGMA(DXR(I),0,0)                                            IYZ04200
00151           IF (SIGY) 670,670,21                                              IYZ04250
00154        21 IF (SIGZ .LE. 0.0.AND.IZMOD(KK) .EQ. 3) GO TO 670                 IYZ04260
00156           CALL PEAK(2,K)                                                    IYZ04300
00157           CALL VERT(K,2)                                                    IYZ04400
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      TMPQ1 = DXR(I)/UBAR(KK)
      DOS(I) = STO1*(STO2+STO3)
      IF (ISKIP(6) .EQ. 1) DOS(I) = DOS(I)*EXP(-DECAY*TMPQ1)
      IF (ISKIP(7) .NE. 2.OR.TIM1 .GE. TMPQ1) GO TO 22
      IF (Z(KK) .GT. ZLIM) GO TO 22
      DOS(I) = DOS(I)*EXP(-LAMBDA*(TMPQ1-TIM1))
   22 CONTINUE
      CON(I) = DOS(I)*UBAR(KK)/(SQR2P*SIGX)
      TMPQ1 = 2.0*SIGY*SIGY
      IF (ISKIP(5) .EQ. 2) GO TO 40
      DO 26 J=1,NDI
      B = DOS(I)/DI(J)
      IF (B .LE. 1.0) GO TO 24
      PLT(1,K,J) = SQRT(TMPQ1*ALOG(B))
      GO TO 26
   24 PLT(1,K,J) = 0.0
   26 CONTINUE
   40 IF (ISKIP(5) .EQ. 1) GO TO 620
      DO 44 J=1,NCI
      B = CON(I)/CI(J)
      IF (B .LE. 1.0) GO TO 42
      PLT(2,K,J) = SQRT(TMPQ1*ALOG(B))
      GO TO 44
   42 PLT(2,K,J) = 0.0
   44 CONTINUE
  620 CONTINUE
      K = K+1
      IF (K .GT. NPTS) GO TO 670
      IF (ZZL(K) .LT. Z(KK+1)) GO TO 20
  670 CONTINUE
C                                 OUTPUT SECTION
      WRITE (6,917) DXR(I)
      IF (ISKIP(5) .EQ. 2) GO TO 680
      WRITE (6,916)
      DO 675 N=1,K
  675 WRITE (6,918) ZZL(N),(DI(J),PLT(1,N,J),J=1,NDI)
  680 IF (ISKIP(5) .EQ. 1) GO TO 690
      WRITE (6,919)
      DO 685 N=1,K
  685 WRITE (6,925) ZZL(N),(CI(J),PLT(2,N,J),J=1,NCI)
  690 CONTINUE
C
  710 CONTINUE
  720 WRITE (6,920)
      RETURN
  915 FORMAT (1H1,38X,54H***** ISOPLETHS VERTICAL PLANE AROUND CLOUD AXI
     1S *****/40X,42H* YW IS LATERAL DISTANCE FROM CLOUD AXIS *///)
  916 FORMAT (60X,12H** DOSAGE **)
  917 FORMAT (56X,21H** RADIAL DISTANCE R=,F10.2,3H **)
  918 FORMAT (10H HEIGHT Z=,F10.2,2(11H, * DOSAGE=,E14.6,5H, YW=,F10.2)/
     1(20X,2(11H, * DOSAGE=,E14.6,5H, YW=,F10.2)))
  919 FORMAT (57X,19H** CONCENTRATION **)
  920 FORMAT (12X,18(6H------)/)
  921 FORMAT (22X,89H* THE DECAY TERM HAS BEEN INCLUDED IN DOSAGE AND CO
     1NCENTRATION IN CALCULATING ISOPLETHS *)
  922 FORMAT (18X,' PRECIPITATION SCAVENGING HAS BEEN INCLUDED IN DOSAGE
     1 AND CONCENTRATION IN CALCULATING ISOPLETHS')
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00317    104*       925 FORMAT (1CH HEIGHT Z=,F10.2,2(18H, * CONCENTRATION=,E14.8,5H, YW=,IYZ10200
00317    105*          1F10.2)/(20X,2(18H, * CONCENTRATION=,E14.8,5H, YW=,F10.2)))         IYZ10300
00320    106*           END                                                                  IYZ10400

      END OF COMPILATION:        NO  DIAGNOSTICS.
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```
@FOR,US READER
FOR 010L-03/14/73-21:37:31 (0,1)

   SUBROUTINE READER    ENTRY POINT 002213

   STORAGE USED: CODE(1) 002230; DATA(0) 000462; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003   PARAMT 002173
    0004   PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005   NRNLS
    0006   NWDUS
    0007   NIO1S
    0010   NIO2S
    0011   ALOG
    0012   NEXP6S
    0013   NWNLS
    0014   NERR3S

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001   000112 10L      0000   000402 1000F    0001   000120 12L      0001   000007 126G     0001   000130 14L
    0001   000032 143G     0001   000037 147G     0001   000617 152L     0001   000633 155L     0001   000136 16L
    0001   000061 161G     0001   000721 162L     0001   000735 165L     0001   001012 172L     0001   000104 175G
    0001   001043 175L     0001   001047 178L     0001   000146 18L      0001   001144 192L     0001   001206 193L
    0001   001213 197L     0001   000020 2L       0001   000154 20L      0001   001244 202L     0001   001265 205L
    0001   001326 210L     0001   001334 215L     0001   001366 222L     0001   001426 225L     0001   001432 228L
    0001   000162 24L      0001   001515 240L     0001   001566 242L     0001   000226 243G     0001   001574 243L
    0001   001640 250L     0001   000243 253G     0001   000170 26L      0001   000252 260G     0001   001730 260L
    0001   000214 27L      0001   001737 270L     0001   001754 280L     0001   002006 290L     0001   000231 30L
    0001   002025 300L     0001   000317 301G     0001   002031 310L     0001   002041 320L     0001   002045 330L
    0001   000407 337G     0001   000246 34L      0001   002047 340L     0001   000433 353G     0001   002154 355L
    0001   002157 360L     0001   000475 370G     0001   002161 370L     0001   000363 40L      0001   000375 42L
    0001   000612 422G     0001   000403 44L      0001   000712 441G     0001   000415 46L      0001   001004 460G
    0001   001017 465G     0001   000423 48L      0001   000064 5L       0001   001075 506G     0001   000462 52L
    0001   000507 54L      0001   001230 540G     0001   001351 553G     0001   000512 57L      0001   001400 571G
    0001   000520 58L      0001   000072 6L       0001   001462 612G     0001   001622 636G     0001   000545 65L
    0001   001666 655G     0001   001772 705G     0001   002116 740G     0001   002124 745G     0001   000100 8L
    0003 R 001725 ACCUR    0003 R 001056 ALPHA    0003 R 001777 ALPHL    0004   001510 ALPHNK   0004   001034 ANG
    0003 R 001114 BETA     0004   001344 BETANK   0003 R 002011 BETL     0000 R 000043 BLAMDA   0003 R 001605 CI
    0004   000264 CON      0003 R 000014 DATE     0003 R 001423 DECAY    0003 R 002172 DELPHI   0004 R 000074 DELTHP
    0004 R 000226 DELU     0003 R 000567 DELX     0003 R 000613 DELY     0004   000066 DEP      0004   001656 DEPN
    0003 R 001573 DI       0000 R 000053 DIF1     0000 R 000054 DIF2     0003 R 000423 DXR      0003 R 001203 H
    0003 R 001776 HB       0004 I 000441 I        0004   000454 IBOT     0003 I 001427 IFLAG    0004 I 000665 II
    0004   000450 ILK      0000   000440 INJPS    0003 I 000016 ISKIP    0004   000502 ITAG     0004   000453 ITOP
    0003 I 001377 IZMOD    0003 I 000016 IZP1     0004 I 000442 J        0003 I 001631 JBOT     0004   000646 JF
    0003 I 001643 JTOP     0004   000443 KK       0004 R 000437 L        0003 R 001426 LAMBDA   0004   025276 LAT
    0004   000652 LB1      0004   000657 LB2      0000 I 000051 M        0004 R 000651 MPWR     0000 I 000052 N
    0000   000055 NAM1     0000   000065 NAM2     0000   000345 NAM3     0003 I 000062 NBK      0003 I 000060 NCI
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NASA/MSFC MULTILAYER DIFFUSION MODEL, VERSION 2  H E CRAMER CO                                    DATE 031473        PAGE    44

 0003 I 000057 NDI        0003 I 000061 NDXR       0004 I 000452 NNZ        0003 I 000063 NPTS       0000 I 000045 NTAK
 0000 I 000044 NIAL       0003 I 000065 NVR        0003 I 000064 NVS        0004   001655 NXCI       0003 I 000054 NXS
 0003 I 000055 NYS        0003 I 000056 NZS        0000 R 000050 P          0004   000432 PEAKO      0003 R 001701 PERC
 0003 R 001752 PERCB      0004 R 000647 PPWR       0003 R 000637 Q          0004 R 000650 QPWR       0004 R 000451 RAD
 0000 R 000046 S          0004 R 001200 SAVE       0003 R 000710 SIGAK      0003 R 002052 SIGAL      0004   025044 SIGANK
 0004 R 000036 SIGAP      0003 R 000735 SIGEK      0003 R 002076 SIGEL      0004   025300 SIGENK     0004 R 000132 SIGEP
 0004   000435 SIGX       0004   000501 SIGXNK     0003 R 000762 SIGXO      0004   000434 SIGY       0004   025277 SIGYNK
 0003 R 001006 SIGYO      0004   000433 SIGZ       0003 R 001032 SIGZO      0004   001654 SQBAR      0004   000436 SQR2P
 0000 R 000042 SR12I      0004   000444 ST01       0004   000445 ST02       0004   000446 ST03       0000 R 000047 S1
 0003 R 002146 T          0003 R 001617 TAST       0003 R 001201 TAUK       0003 R 002023 TAUL       0003 R 001202 TAUOK
 0003 R 002024 TAUOL      0003 I 000000 TESTNO     0004   000440 TH         0004 R 000170 THETA      0003 R 001154 THETAK
 0003 R 002122 THETAL     0003 R 001153 TIMAV      0003 R 001425 TIM1       0004   000447 TRD        0004 R 000000 UBAR
 0003 R 000663 UBARK      0003 R 002026 UBARL      0004   001200 UBARNK     0003 R 001726 VB         0004   000430 VER
 0004   000431 VREF       0003 R 001655 VS         0004   000455 XAST       0004   001033 XBARX      0003 R 001231 XLRY
 0003 R 001232 XLRZ       0003 R 001227 XRY        0003 R 001230 XRZ        0000 R 000000 XSV        0003 R 000066 XX
 0004   000667 YBARY      0003 R 000232 YY         0003 R 000376 Z          0003 R 001424 ZLIM       0003 R 001152 ZRK
 0003 R 002025 ZKL        0003 R 001233 ZZL


00101      1*        SUBROUTINE READER(IFF,NP)                                           RDR00100
00103      2*        COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI, RDR00200
00103      3*       1NDXR,NBK,NPTS,NVS,NVR,XX(100),YY(100),Z(21),DXR(100),DELX(20),    RDR00300
00103      4*       2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20), RDR00400
00103      5*       3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)RDR00500
00103      6*       4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,    RDR00600
00103      7*       5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),       RDR00700
00103      8*       6PERC(20),ACCUR,VB(20),PERCB(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL, RDR00800
00103      9*       7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI          RDR00900
00104     10*        COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),RDR01000
00104     11*       1DELU(30),CUR(100),VER,VREF,PEAKO,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,RDR01100
00104     12*       2ST01,ST02,ST03,TRD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)RDR01200
00104     13*       3,JF,PPWR,QPWR,MPWR,LB1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),RDR01300
00104     14*       4UBARNK(100),BETANK(100),ALPHNK(100),SQBAR,NXCI,DEPN(100,100),LAT, RDR01400
00104     15*       5SIGYNK,SIGENK(100),SIGANK(100)                                     RDR01500
00104     16*   C    THIS SUBROUTINE READS ALL INPUT DATA AND CALCULATES NECESSARY      RDR01600
00104     17*   C    LAYER PARAMETERS                                                   RDR01700
00105     18*        INTEGER TESTNO                                                     RDR01800
00106     19*        REAL MPWR,L,LAMBDA                                                 RDR01900
00107     20*        DIMENSION XSV(34),SAVE(30),IZR1(1)                                 RDR02000
00110     21*        EQUIVALENCE (SAVE,UBARNK),(IZR1,ISKIP)                             RDR02100
00110     22*   C    DEFAULT XX AND DXR VALUES                                          RDR02200
00111     23*        DATA XSV/500.,600.,700.,800.,900.,1000.,1250.,1500.,1750.,2000., RDR02300
00111     24*       12500.,3000.,3500.,4000.,5000.,6000.,7000.,8000.,9000.,10000.,    RDR02400
00111     25*       212500.,15000.,17500.,20000.,25000.,30000.,35000.,40000.,50000., RDR02500
00111     26*       360000.,70000.,80000.,90000.,100000./                              RDR02600
00111     27*   C    MACHINE DEPENDENT STATEMENT ASSUMES SIX BYTES/WORD                 RDR02700
00113     28*        DATA TESTNO/12*6H      /,DATE/2*6H      /                          RDR02800
00116     29*        DATA SR12I/2.886751E-01/                                           RDR02900
00116     30*   C    SR12I =  1.0/SQRT(12.0)                                            RDR03000
00120     31*        NAMELIST /NAM1/ DATE,NP                                            RDR03100
00121     32*        NAMELIST /NAM2/ TESTNO,ISKIP,NXS,NYS,NZS,NDI,NCI,NDXR,NBK,NPTS,  RDR03200
00121     33*       1NVS,NVR,XX,YY,Z,DXR,DELX,DELY,Q,UBARK,SIGAK,SIGEK,SIGXO,SIGYO,    RDR03300
00121     34*       2SIGZO,ALPHA,BETA,ZRK,TIMAV,THETAK,TAUK,TAUOK,H,XRY,XRZ,XLRY,XLRZ, RDR03400
00121     35*       3ZZL,IZMOD,DECAY,ZLIM,TIM1,LAMBDA,IFLAG,DI,CI,TAST,JBOT,JTOP,      RDR03500
00121     36*       4VS,PERC,ACCUR,VB,PERCB,HB,T,DELPHI                                 RDR03600
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00122            NAMELIST/NAM3/ ALPHL,BETL,TAUL,TAUOL,ZRL,                  RDR03700
00122           1UBARL,SIGAL,SIGEL,THETAL                                   RDR03800
00123            IF (IFF .GT. 1) GO TO 2                                    RDR03900
00123      C     ZERO OUT INPUT LISTS FOR PROCESSORS WHERE CORE IS NOT      RDR04000
00123      C     INITIALIZED TO ZERO. 1147 IS LENGTH OF COMMON/PARAMT/ MINUS RDR04100
00123      C     12 FOR TESTNO AND 2 FOR DATE                               RDR04150
00125            DO 1 I=1,1133                                              RDR04200
00130          1 IZR1(I) = 0                                                RDR04300
00132            READ (5,NAM1)                                              RDR04400
00135            RETURN                                                     RDR04500
00136          2 READ (5,NAM2)                                              RDR04600
00141            WRITE (6,1000) TESTNO,DATE                                 RDR04700
00153            NNZ = NZS-1                                                RDR04800
00154            LAMBDA = BLAMDA                                            RDR04900
00155            IF (NXS .GT. 0) GO TO 5                                    RDR05000
00155      C     DEFAULT XX                                                 RDR05100
00157            NXS = 34                                                   RDR05200
00160            DO 4 I=1,NXS                                               RDR05300
00163          4 XX(I) = XSV(I)                                             RDR05400
00165          5 CONTINUE                                                   RDR05500
00166            IF (TAUOK .GT. 0.0) GO TO 6                                RDR05600
00166      C     DEFAULT TAUOK                                              RDR05700
00170            TAUOK = 600.0                                              RDR05800
00171          6 IF (DELPHI .GT. 0.0) GO TO 8                               RDR05900
00171      C     DEFAULT DELPHI                                             RDR06000
00173            DELPHI = 100.0                                             RDR06100
00174          8 DO 16 I=1,NNZ                                              RDR06200
00177            IF (ALPHA(I) .GT. 0.0) GO TO 10                            RDR06300
00177      C     DEFAULT ALPHA                                              RDR06400
00201            ALPHA(I) = 1.0                                             RDR06500
00202         10 IF (BETA(I) .GT. 0.0) GO TO 12                             RDR06600
00202      C     DEFAULT BETA                                               RDR06700
00204            BETA(I) = 1.0                                              RDR06800
00205         12 IF (SIGZO(I) .GT. 0.0) GO TO 14                            RDR06900
00205      C     DEFAULT SIGZO                                              RDR07000
00207            SIGZO(I) = (Z(I+1)-Z(I))*SR12I                             RDR07100
00210         14 IF (IZMOD(I) .GT. 0) GO TO 16                              RDR07200
00210      C     DEFAULT IZMOD                                              RDR07300
00212            IZMOD(I) = 1                                               RDR07400
00213         16 CONTINUE                                                   RDR07500
00215            IF (XRY .GT. 0.0) GO TO 18                                 RDR07600
00215      C     DEFAULT XRY                                                RDR07700
00217            XRY = 100.0                                                RDR07800
00220         18 IF (XRZ .GT. 0.0) GO TO 20                                 RDR07900
00220      C     DEFAULT XRZ                                                RDR08000
00222            XRZ = 100.0                                                RDR08100
00223         20 IF (TIMAV .GT. 0.0) GO TO 24                               RDR08200
00223      C     DEFAULT TIMAV                                              RDR08300
00225            TIMAV = 600.0                                              RDR08400
00226         24 IF (ZRK .GT. 0.0) GO TO 26                                 RDR08500
00226      C     DEFAULT ZRK                                                RDR08600
00230            ZRK = 2.0                                                  RDR08650
00231         26 IF (ISKIP(7) .EQ. 0.OR.ISKIP(7) .EQ. 2) GO TO 27           RDR08700
00233            IF (ISKIP(2) .EQ. 0) ISKIP(2) = 1                          RDR08750
00235            IF (NPTS .LT. NNZ) NPTS = 0                                RDR08800
00237         27 IF (NPTS .GT. 0) GO TO 30                                  RDR08850
00241            NPTS = NNZ                                                 RDR08900
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00242     94*          DO 28 I=1,NNZ                                    RDR09000
00242     95*     C    DEFAULT ZZL                                      RDR09100
00245     96*       28 ZZL(I) = Z(I)                                    RDR09200
00247     97*       30 IF (NDXR .GT. 0) GO TO 34                        RDR09300
00251     98*          NDXR = 34                                        RDR09400
00252     99*          DO 32 I=1,NXS                                    RDR09500
00252    100*     C    DEFAULT DXR                                      RDR09600
00255    101*       32 DXR(I) = XSV(I)                                  RDR09700
00257    102*       34 DO 36 I=1,NZS                                    RDR09800
00257    103*     C    CHECK MINIMUM LIMITS                             RDR09900
00262    104*          IF (SIGAK(I) .LT. .5) SIGAK(I) = .5              RDR10000
00264    105*          IF (SIGEK(I) .LT. .1) SIGEK(I) = .1              RDR10100
00266    106*          IF (UBARK(I) .LT. .1) UBARK(I) = .1              RDR10200
00270    107*       36 CONTINUE                                         RDR10300
00272    108*          IF (NBK .EQ. 0) GO TO 57                         RDR10400
00274    109*          IF (ISKIP(2) .EQ. 3) GO TO 40                    RDR10500
00274    110*     C    DETERMINE LAYER CHANGE PARAMETERS                RDR10600
00276    111*          ZRL = ZRK                                        RDR10700
00277    112*          II = -1                                          RDR10800
00300    113*          DO 38 I=1,NBK                                    RDR10900
00303    114*          II = II+2                                        RDR11000
00304    115*          NTAL = JBOT(I)                                   RDR11100
00305    116*          NTAK = JTOP(I)                                   RDR11200
00306    117*          UBARL(II) = UBARK(NTAL)                          RDR11300
00307    118*          UBARL(II+1) = UBARK(NTAK+1)                      RDR11400
00310    119*          SIGAL(II) = SIGAK(NTAL)                          RDR11500
00311    120*          SIGAL(II+1) = SIGAK(NTAK+1)                      RDR11600
00312    121*          SIGEL(II) = SIGEK(NTAL)                          RDR11700
00313    122*          SIGEL(II+1) = SIGEK(NTAK+1)                      RDR11800
00314    123*          THETAL(II) = THETAK(NTAL)                        RDR11900
00315    124*          THETAL(II+1) = THETAK(NTAK+1)                    RDR12000
00316    125*          ALPHL(I) = ALPHA(NTAL)                           RDR12100
00317    126*          BETL(I) = BETA(NTAL)                             RDR12200
00320    127*       38 CONTINUE                                         RDR12300
00322    128*          TAUOL = TAUOK                                    RDR12400
00323    129*          TAUL = TAUK                                      RDR12500
00324    130*          GO TO 52                                         RDR12600
00325    131*       40 READ (5,NAM3)                                    RDR12700
00325    132*     C    READ LAYER CHANGE PARAMETERS                     RDR12800
00330    133*          IF (TAUOL .GT. 0.0) GO TO 42                     RDR12900
00330    134*     C    DEFAULT TAUOL                                    RDR13000
00332    135*          TAUOL = 600.0                                    RDR13100
00333    136*       42 IF (ZRL .GT. 0.0) GO TO 44                       RDR13200
00333    137*     C    DEFAULT ZRL                                      RDR13300
00335    138*          ZRL = 18.0                                       RDR13400
00336    139*       44 DO 48 I=1,NBK                                    RDR13500
00341    140*          IF (ALPHL(I) .GT. 0.0) GO TO 46                  RDR13600
00341    141*     C    DEFAULT ALPHL                                    RDR13700
00343    142*          ALPHL(I) = 1.0                                   RDR13800
00344    143*       46 IF (BETL(I) .GT. 0.0) GO TO 48                   RDR13900
00344    144*     C    DEFAULT BETL                                     RDR14000
00346    145*          BETL(I) = 1.0                                    RDR14100
00347    146*       48 CONTINUE                                         RDR14200
00351    147*          NTAL = 2*NBK                                     RDR14300
00352    148*          DO 50 I=1,NTAL                                   RDR14400
00352    149*     C    CHECK MINIMUM VALUES                             RDR14500
00355    150*          IF (SIGAL(I) .LT. .5) SIGAL(I) = .5              RDR14600
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00357            IF (UBARL(I) .LT. .1) UBARL(I) = .1                            RDR14700
00361            IF (SIGEL(I) .LT. .1) SIGEL(I) = .1                            RDR14800
00363         50 CONTINUE                                                       RDR14900
00365         52 NTAK = NNZ+1                                                   RDR15000
00366            NTAL = NNZ+NBK                                                 RDR15100
00366      C     COMBINE ALPHA AND BETA WITH ALPHL AND BETL                     RDR15200
00367            DO 54 I=NTAK,NTAL                                              RDR15300
00372            ALPHA(I) = ALPHL(I-NNZ)                                        RDR15400
00373            BETA(I) = BETL(I-NNZ)                                          RDR15500
00374            IF (TAST(I-NNZ) .GT. 0.0) GO TO 54                             RDR15600
00374      C     DEFAULT TAST                                                   RDR15700
00376            TAST(I-NNZ) = 1.0                                              RDR15800
00377         54 CONTINUE                                                       RDR15900
00401         57 IF (Z(1) .GT. 0.0) GO TO 58                                    RDR16000
00401      C     MINIMUM Z                                                      RDR16100
00403            Z(1) = 2.0                                                     RDR16200
00404         58 CONTINUE                                                       RDR16300
00405            S = (Z(2)/ZRK)                                                 RDR16400
00406            S1 = 1.0/ALOG(S)                                               RDR16500
00407            P = ALOG(UBARK(2)/UBARK(1))*S1                                 RDR16600
00410            IF (P+1.0)  65,64,65                                           RDR16700
00413         64 P = -.9999999                                                  RDR16800
00414         65 CONTINUE                                                       RDR16900
00414      C     CALCULATE UBAR FOR LAYER 1                                     RDR17000
00415            UBAR(1) = (UBARK(1)/((1.0+P)*(Z(2)-ZRK)*ZRK**P))*(Z(2)**(1.0+P)-  RDR17100
00415           1ZRK**(1.0+P))                                                  RDR17200
00416             PPWR = P                                                      RDR17300
00417            IF (NNZ .LT. 2) GO TO 152                                      RDR17400
00421            DO 150 I=2,NNZ                                                 RDR17500
00421      C     CALCULATE UBAR FOR LAYERS 2 TO NNZ                             RDR17600
00424        150 UBAR(I) = 0.5*(UBARK(I+1)+UBARK(I))                            RDR17700
00426        152 P = ALOG(SIGAK(2)/SIGAK(1))*S1                                 RDR17800
00427            IF (P + 1.0) 155,154,155                                       RDR17900
00432        154 P = -.9999999                                                  RDR18000
00433        155 CONTINUE                                                       RDR18100
00433      C     CALCULATE SIGAP FOR LAYER 1                                    RDR18200
00434            SIGAP(1) = ((SIGAK(1)*(TAUK/TAUOK)**(0.2)*RAD)/((1.0+P)*       RDR18300
00434           1(Z(2)-ZRK)*ZRK**P))*(Z(2)**(1.0+P)-ZRK**(1.0+P))               RDR18400
00435            NPWR = P                                                       RDR18500
00436            IF (NNZ .LT. 2) GO TO 162                                      RDR18600
00440            DO 160 I=2,NNZ                                                 RDR18700
00440      C     CALCULATE SIGAP FOR LAYERS 2 TO NNZ                            RDR18800
00443        160 SIGAP(I) = ((SIGAK(I+1)+SIGAK(I))*(TAUK/TAUOK)**(0.2)*RAD)*0.5 RDR18900
00445        162 P = ALOG(SIGEK(2)/SIGEK(1))*S1                                 RDR19000
00446            IF (P + 1.0) 165,164,165                                       RDR19100
00451        164 P = -.9999999                                                  RDR19200
00452        165 CONTINUE                                                       RDR19300
00452      C     CALCULATE SIGEP FOR LAYER 1                                    RDR19400
00453            SIGEP(1) = (SIGEK(1)/((1.0+P)*(Z(2)-ZRK)*ZRK**P))*(Z(2)**(1.0+P)-  RDR19500
00453           1ZRK**(1.0+P))*RAD                                              RDR19600
00454            IF (NNZ .LT. 2) GO TO 172                                      RDR19700
00456             QPWR = P                                                      RDR19800
00457            DO 170 I=2,NNZ                                                 RDR19900
00457      C     CALCULATE SIGEP FOR LAYERS 2 TO NNZ                            RDR20000
00462        170 SIGEP(I) = ((SIGEK(I+1)+SIGEK(I))*RAD)*0.5                     RDR20100
00464        172 DO 180 I=1,NNZ                                                 RDR20200
00467            J = I                                                          RDR20300
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00467     206*     C      CALCULATE THETA FOR ALL LAYERS                                RDR20400
00470     209*            IF (ABS(THETAK(J)-THETAK(J+1)) .LT. 180.0) GO TO 178          RDR20500
00472     210*            IF (THETAK(J) .GT. THETAK(J+1)) GO TO 175                     RDR20600
00474     211*            THETAK(J) = THETAK(J)+360.0                                   RDR20700
00475     212*            GO TO 178                                                     RDR20800
00476     213*        175 THETAK(J+1) = THETAK(J+1)+360.0                               RDR20900
00477     214*        178 CONTINUE                                                      RDR21000
00500     215*            THETA(I) = (THETAK(J)+THETAK(J+1))*0.5                        RDR21100
00501     216*            IF (THETA(I) .GE. 360.0) THETA(I) = THETA(I)-360.0            RDR21200
00501     217*     C      CALCULATE DELTHP FOR ALL LAYERS                               RDR21300
00503     218*        180 DELTHP(I) = (THETAK(J+1)-THETAK(J))                           RDR21400
00505     219*            DO 185 I=1,NNZ                                                RDR21500
00505     220*     C      CALCULATE DELU FOR ALL LAYERS                                 RDR21600
00510     221*        185 DELU(I) = UBARK(I+1)-UBARK(I)                                 RDR21700
00512     222*            IF (ISKIP(1) .GT. 0) GO TO 250                                RDR21800
00514     223*            IF (NBK .EQ. 0) GO TO 250                                     RDR21900
00516     224*            M = JTOP(1)                                                   RDR22000
00517     225*            IF (JBOT(1) .GT. 1) GO TO 193                                 RDR22100
00521     226*            S = (Z(M+1)/ZRL)                                              RDR22200
00522     227*            S1 = 1.0/ALOG(S)                                              RDR22300
00523     228*            P = ALOG(UBARL(2)/UBARL(1))*S1                                RDR22400
00524     229*            IF (P + 1.0) 192,191,192                                      RDR22500
00527     230*        191 P = -.9999999                                                 RDR22600
00530     231*        192 CONTINUE                                                      RDR22700
00530     232*     C      CALCULATE UBAR FOR NEW LAYER 1 (IF CONTAINS SURFACE)          RDR22800
00531     233*            UBAR(NNZ+1) = (UBARL(1)/((1.0+P)*(Z(M+1)-ZRL)*ZRL**P))*(Z(M+1)** RDR22900
00531     234*           1(1.0+P)-ZRL**(1.0+P))                                         RDR23000
00532     235*            QPWR = P                                                      RDR23100
00533     236*            GO TO 197                                                     RDR23200
00533     237*     C      CALCULATE UBAR FOR NEW LAYER 1 (IF DOES'NT CONTAIN SURFACE)   RDR23300
00534     238*        193 UBAR(NNZ+1) = (UBARL(1)+UBARL(2))*0.5                         RDR23400
00535     239*        197 IF (NBK .LT. 2) GO TO 202                                     RDR23500
00537     240*            DO 200 I=2,NBK                                                RDR23600
00542     241*            J = I*2-1                                                     RDR23700
00542     242*     C      CALCULATE UBAR FOR NEW LAYERS 2 TO NBK                        RDR23800
00543     243*        200 UBAR(NNZ+I) = (UBARL(J+1)+UBARL(J))*0.5                       RDR23900
00545     244*        202 IF (JBOT(1) .GT. 1) GO TO 210                                 RDR24000
00547     245*            P = ALOG(SIGEL(2)/SIGEL(1))*S1                                RDR24100
00550     246*            IF (P + 1.0) 205,204,205                                      RDR24200
00553     247*        204 P = -.9999999                                                 RDR24300
00554     248*        205 CONTINUE                                                      RDR24400
00554     249*     C      CALCULATE SIGEP FOR NEW LAYER 1 (IF CONTAINS SURFACE)         RDR24500
00555     250*            SIGEP(NNZ+1) = (SIGEL(1)/((1.0+P)*(Z(M+1)-ZRL)*ZRL**P))*(Z(M+1)** RDR24600
00555     251*           1(1.0+P)-ZRL**(1.0+P))*RAD                                     RDR24700
00556     252*            GO TO 215                                                     RDR24800
00556     253*     C      CALCULATE SIGEP FOR NEW LAYER 1 (IF DOES'NT CONTAIN SURFACE)  RDR24900
00557     254*        210 SIGEP(NNZ+1) = ((SIGEL(2)+SIGEL(1))*RAD)*0.5                  RDR25000
00560     255*        215 IF (NBK .LT. 2) GO TO 222                                     RDR25100
00562     256*            DO 220 I=2,NBK                                                RDR25200
00565     257*            J = I*2-1                                                     RDR25300
00565     258*     C      CALCULATE SIGEP FOR NEW LAYERS 2 TO NBK                       RDR25400
00566     259*        220 SIGEP(NNZ+I) = ((SIGEL(J+1)+SIGEL(J))*RAD)*0.5                RDR25500
00570     260*        222 DO 230 I=1,NBK                                                RDR25600
00573     261*            J = I*2-1                                                     RDR25700
00573     262*     C      CALCULATE THETA FOR NEW LAYERS 1 TO NBK                       RDR25800
00574     263*            IF (ABS(THETAL(J)-THETAL(J+1)) .LT. 180.0) GO TO 228          RDR25900
00576     264*            IF (THETAL(J) .GT. THETAL(J+1)) GO TO 225                     RDR26000
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00600    265*           THETAL(J) = THETAL(J)+360.0                                      RDR26100
00601    266*           GO TO 228                                                        RDR26200
00602    267*       225 THETAL(J+1) = THETAL(J+1)+360.0                                  RDR26300
00603    268*       228 CONTINUE                                                         RDR26400
00604    269*           THETA(NNZ+1) = (THETAL(J)+THETAL(J+1))*0.5                       RDR26500
00605    270*           IF (THETA(NNZ+I) .GE. 360.0) THETA(NNZ+I) = THETA(NNZ+I)-360.0   RDR26600
00605    271*     C     CALCULATE DELTHP FOR ALL NEW LAYERS                              RDR26700
00607    272*       230 DELTHP(NNZ+I) = (THETAL(J+1)-THETAL(J))                          RDR26800
00611    273*           DO 235 I=1,NBK                                                   RDR26900
00614    274*           J = I*2-1                                                        RDR27000
00614    275*     C     CALCULATE DELTHP FOR ALL NEW LAYERS                              RDR27100
00615    276*       235 DELU(NNZ+I) = UBARL(J+1)-UBARL(J)                                RDR27200
00617    277*       237 IF (JBOT(1) .GT. 1) GO TO 242                                    RDR27300
00621    278*           P = ALOG(SIGAL(2)/SIGAL(1))*S1                                   RDR27400
00622    279*           IF (P + 1.0) 240,239,240                                         RDR27500
00625    280*       239 P = -.9999999                                                    RDR27600
00626    281*       240 CONTINUE                                                         RDR27700
00626    282*     C     CALCULATE SIGAP FOR NEW LAYER 1 (IF CONTAINS SURFACE)            RDR27800
00627    283*           SIGAP(NNZ+1) = ((SIGAL(1)*(TAUL/TAUOL)**(0.2)*RAD)/((1.0+P)      RDR27900
00627    284*          1*(Z(M+1)-ZRL)*ZRL**P))*(Z(M+1)**(1.0+P)-ZRL**(1.0+P))            RDR28000
00630    285*           GO TO 243                                                        RDR28100
00630    286*     C     CALCULATE SIGAP FOR NEW LAYER 1 (IF DOES'NT CONTAIN SURFACE)     RDR28200
00631    287*       242 SIGAP(NNZ+1) = ((SIGAL(2)+SIGAL(1))*RAD)*0.5                     RDR28300
00632    288*       243 CONTINUE                                                         RDR28400
00633    289*           IF (NBK .LT. 2) GO TO 250                                        RDR28500
00635    290*           DO 245 I=2,NBK                                                   RDR28600
00640    291*           J = I*2-1                                                        RDR28700
00640    292*     C     CALCULATE SIGAP FOR NEW LAYERS 2 TO NBK                          RDR28800
00641    293*       245 SIGAP(NNZ+I) = ((SIGAL(J+1)+SIGAL(J))*(TAUL/TAUOL)**(0.2)*RAD)*0.5RDR28900
00643    294*       250 CONTINUE                                                         RDR29000
00644    295*           IF (ISKIP(6) .EQ. 0) DECAY = 0.0                                 RDR29100
00646    296*           IF (NYS .GT. 0) GO TO 370                                        RDR29200
00650    297*           IF (ISKIP(1) .EQ. 0.AND.ISKIP(2) .EQ. 0) GO TO 370               RDR29300
00650    298*     C     DEFAULT YY                                                       RDR29400
00652    299*           N = 1                                                            RDR29500
00653    300*           J = 0                                                            RDR29600
00654    301*           DO 280 I=1,NNZ                                                   RDR29700
00657    302*           IF (NBK .EQ. 0) GO TO 260                                        RDR29800
00661    303*           IF (I .GT. JTOP(N)) N = N+1                                      RDR29900
00663    304*           IF (N .GT. NBK) GO TO 260                                        RDR30000
00665    305*           IF (JBOT(N) .LE. I.AND.I .LE. JTOP(N)) GO TO 270                 RDR30100
00667    306*       260 J = J+1                                                          RDR30200
00670    307*           SAVE(J) = THETA(I)                                               RDR30300
00671    308*           GO TO 280                                                        RDR30400
00672    309*       270 IF (JBOT(N) .NE. I) GO TO 280                                    RDR30500
00674    310*           J = J+1                                                          RDR30600
00675    311*           SAVE(J) = THETA(NNZ+N)                                           RDR30700
00676    312*       280 CONTINUE                                                         RDR30800
00700    313*           DIF1 = SAVE(1)                                                   RDR30900
00701    314*           DIF2 = SAVE(1)                                                   RDR31000
00702    315*           IF (J .LE. 1) GO TO 340                                          RDR31100
00704    316*           DO 330 I=2,J                                                     RDR31200
00707    317*           IF (SAVE(I) .GT. SAVE(I-1)) GO TO 310                            RDR31300
00711    318*           IF (ABS(SAVE(I)-SAVE(I-1)) .GT. 180.0) GO TO 300                 RDR31400
00713    319*       290 IF (SAVE(I) .GT. DIF1) DIF1 = SAVE(I)                            RDR31500
00715    320*           IF (SAVE(I) .LT. DIF2) DIF2 = SAVE(I)                            RDR31600
00717    321*           GO TO 330                                                        RDR31700
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00720    322*        300 SAVE(I) = SAVE(I)+360.0                                           RDR31800
00721    323*            GO TO 330                                                         RDR31900
00722    324*        310 IF (ABS(SAVE(I)-SAVE(I-1)) .GT. 180.0) GO TO 320                  RDR32000
00724    325*            GO TO 290                                                         RDR32100
00725    326*        320 SAVE(I) = SAVE(I)-360.0                                           RDR32200
00726    327*            GO TO 290                                                         RDR32300
00727    328*        330 CONTINUE                                                          RDR32400
00731    329*        340 DIF1 = DIF1+0.5*DELPHI                                            RDR32500
00732    330*            DIF2 = DIF2-0.5*DELPHI                                            RDR32600
00733    331*            NYS = ((DIF1-DIF2)/5.0)+1.0                                       RDR32700
00734    332*            N = DIF2/5.0                                                      RDR32800
00735    333*            DIF2 = N*5                                                        RDR32900
00736    334*            YY(1) = DIF2                                                      RDR33000
00737    335*            DO 350 I=2,NYS                                                    RDR33100
00742    336*        350 YY(I) = YY(I-1)+5.0                                               RDR33200
00744    337*            DO 360 I=1,NYS                                                    RDR33300
00747    338*            IF (YY(I) .GT. 360.0) YY(I) = YY(I)-360.0                         RDR33400
00751    339*            IF (YY(I) .LT. 0.0) YY(I) = YY(I)+360.0                           RDR33500
00753    340*            IF (YY(I) .LT. 180.0) GO TO 355                                   RDR33600
00755    341*            YY(I) = YY(I)-180.0                                               RDR33700
00756    342*            GO TO 360                                                         RDR33800
00757    343*        355 YY(I) = YY(I)+180.0                                               RDR33900
00760    344*        360 CONTINUE                                                          RDR34000
00762    345*        370 CONTINUE                                                          RDR34100
00763    346*            WRITE (6,NAM2)                                                    RDR34200
00766    347*            IF (ISKIP(2) .EQ. 3) WRITE (6,NAM3)                               RDR34300
00772    348*            RETURN                                                            RDR34400
00772    349*      C     MACHINE DEPENDENT STATEMENT ASSUMES SIX BYTES/WORD                RDR34500
00773    350*       1000 FORMAT ('1',11X,'*-*-* TITLE=',12A6,'! DATE=',2A6,' *-*-*'/)      RDR34600
00774    351*            END                                                               RDR34700

     END OF COMPILATION:        NO  DIAGNOSTICS.
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@FOR,US SGP
FOR 010L-03/14/73-21:37:37 (0,1)

   SUBROUTINE SGP        ENTRY POINT 001057
              UBARS      ENTRY POINT 001135
              DEPSO      ENTRY POINT 001213
              BETAK      ENTRY POINT 001247

   STORAGE USED: CODE(1) 001321; DATA(0) 000060; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003    PARAMT 002173
    0004    PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005    NEXP6$
    0006    SIN
    0007    COS
    0010    ATAN
    0011    SQRT
    0012    EXP
    0013    NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001    000052 10L      0001    000041 127G     0001    000234 175G     0001    000056 20L      0001    000764 275G
    0001    000067 30L      0001    000104 35L      0001    000114 40L      0001    000136 42L      0001    000020 5L
    0001    000307 50L      0001    000374 52L      0001    000425 54L      0001    000466 56L      0001    000472 60L
    0001    000556 65L      0001    001017 90L      0001    001025 95L      0003    001725 ACCUR    0003 R 001056 ALPHA
    0003    001777 ALPHL    0004 R 001510 ALPHNK    0004 R 001034 ANG      0003 R 001114 BETA      0004 R 001344 BETANK
    0003    002011 BETL     0003    001665 CI       0004    000264 CON      0003    000014 DATE     0003    001423 DECAY
    0003    002172 DELPHI   0004    003074 DELTHP   0004    000226 DELU     0003    000557 DELX     0003    000613 DELY
    0004 R 000666 DEP      0004    001656 DEPN     0003    001573 DI       0004 R 000455 DTHK      0003    000423 DXR
    0003    001203 H        0003 R 001776 HB       0000 R 000002 HHNK     0000 R 000003 HHRK      0004    000441 I
    0004    000454 IBOT     0003    001427 IFLAG    0004 I 003665 II       0004    000450 ILK      0000    000033 INJP$
    0003    000016 ISKIP    0004    000502 ITAG     0004    000453 ITOP     0003    001377 IZMOD    0004    000442 J
    0003    001631 JBOT     0004 I 003645 JF       0003    001643 JTOP     0004    000443 KK       0004 R 000437 L
    0003 R 001426 LAMBDA   0004    025276 LAT      0004    000652 LB1      0004    000057 LB2      0000 I 000005 M
    0000 I 000001 MM       0004 R 000651 MPWR     0003    000062 NBK      0003    000060 NCI      0003    000057 NDI
    0003    000061 NDXR     0004    000452 NNZ      0003    000063 NPTS     0003    000065 NVB      0003    000064 NVS
    0004 I 001555 NXCI     0003    000054 NXS      0003    000055 NYS      0003    000056 NZS      0004    000432 PEAKD
    0003 R 001701 PERC     0003 R 001752 PERCB    0000 R 000016 PERK     0004 R 000047 PPWR      0000 R 000010 PWR
    0003 R 000637 W        0004 R 000650 QPWR     0004 R 000451 RAD      0000 R 000000 S        0000 R 000006 SG1
    0000 R 000007 SG2      0000 R 000004 SG3      0003    000710 SIGAK    0003    002052 SIGAL    0004 R 025444 SIGANK
    0004 R 000036 SIGAP    0003 R 000735 SIGEK    0003    002076 SIGEL    0004 R 025330 SIGENK    0004    000132 SIGEP
    0004    000435 SIGX     0004    000501 SIGXNK   0003    000762 SIGXO    0004    000434 SIGY     0004 R 025277 SIGYNK
    0003 R 001606 SIGYO    0004    000433 SIGZ     0003 R 001032 SIGZO    0004 R 001654 SQBAR     0004    000436 SQR2P
    0004    000444 STO1     0004    000445 STO2     0004    000446 STO3     0000 R 000012 S1       0000 R 000013 S2
    0000 R 000017 S3       0003 R 002146 T        0003    001617 TAST     0003    001201 TAUK     0003    002023 TAUL
    0003    001202 TAUOK    0003    002024 TAUOL    0003 I 000000 TESTNO   0004    000440 TH       0004    000170 THETA
    0003    001154 THETAK   0003    002122 THETAL   0003    001153 TIMAV    0003    001425 TIM1     0000 R 000014 TMP01
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0000 R 000023 TMPQ2      0004   000447 TRD      0004 R 000000 UBAR     0003 R 000663 UBARK    0003   002026 UBARL
0004 R 001200 UBARNK     0003 R 001726 VB       0004   000430 VER      0004   000431 VREF     0003 R 001655 VS
0000 R 000011 VV         0004   000455 XAST     0004 R 001033 XBARX    0000 R 000021 XJNK     0000 R 000020 XKNK
0003   001231 XLRY       0003   001232 XLRZ     0003   001227 XRY      0003   001230 XRZ      0003   000066 XX
0000 R 000015 XXX        0000 R 000022 XY       0004 R 000667 YBARY    0003   000232 YY       0003 R 000376 Z
0003   001424 ZLIM       0003 R 001152 ZRK      0003   002025 ZRL      0003 R 001233 ZZL

00101         SUBROUTINE SGP(ZH,N,SIG,IN)                                         SGP00100
00103         COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI,   SGP00200
00103        1NDXR,NBK,NPTS,NVS,NVB,XX(100),YY(100),Z(21),DXR(100),DELX(20),     SGP00300
00103        2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20),  SGP00400
00103        3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)SGP00500
00103        4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,      SGP00600
00103        5IFLAG(100),DI(10),CI(10),TAST(10),JPOT(10),JTOP(10),VS(20),        SGP00700
00103        6PERC(20),ACCUR,VB(20),PERCB(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL,  SGP00800
00103        7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI          SGP00900
00104         COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),SGP01000
00104        1DELU(30),CON(100),VER,VREF,PEAKD,SIGZ,SIGY,SIGX,SGR2P,L,TH,I,J,KK,SGP01100
00104        2ST01,ST02,ST03,TRD,ILK,PAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)SGP01200
00104        3,JF,PPWR,CPWR,MPWR,LB1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),SGP01300
00104        4UBARNK(100),BETANK(100),ALPHNK(100),SQBAR,NXCI,DEPN(100,100),LAT,  SGP01400
00104        5SIGYNK,SIGENK(100),SIGANK(100)                                     SGP01500
00105         DIMENSION DTHK(21)                                                  SGP01600
00106         EQUIVALENCE (XAST,DTHK)                                             SGP01700
00107         INTEGER TESTNO                                                      SGP01800
00110         REAL MPWR,L,LAMBDA                                                  SGP01900
00110   C     SUBROUTINE SGP CALCULATES SIGENK AND SIGANK WITH OR WITHOUT         SGP02000
00110   C     DESTRUCT IN THE LAYER.                                              SGP02100
00111         S = 0.0                                                             SGP02200
00112         MN = N-1                                                            SGP02300
00113         HHNK = ZH                                                           SGP02400
00114         HHRK = 1.0                                                          SGP02500
00115         IF (N .EQ. 1) GO TO 5                                               SGP02600
00117         HHRK = ZH                                                           SGP02700
00120         HHNK = Z(N+1)                                                       SGP02800
00121       5 SG3 = SIGEK(1)                                                      SGP02900
00122         IF (IN .EQ. 2) SG3 = SIGAP(1)                                       SGP03000
00124         IF (N .LE. 2) GO TO 30                                              SGP03100
00126         DO 25 M=2,MN                                                        SGP03200
00131         IF (IN .EQ. 2) GO TO 10                                             SGP03300
00133         SG1 = SIGEK(M+1)                                                    SGP03400
00134         SG2 = SIGEK(M)                                                      SGP03500
00135         GO TO 20                                                            SGP03600
00136      10 SG1 = SIGAP(M+1)                                                    SGP03700
00137         SG2 = SIGAP(M)                                                      SGP03800
00140      20 S = S+(SG1+SG2)*(Z(M+1)-Z(M))*0.5                                   SGP03900
00141      25 CONTINUE                                                            SGP04000
00143      30 IF (IN .EQ. 2) GO TO 35                                             SGP04100
00145         SG1 = SIGEK(N+1)                                                    SGP04200
00146         SG2 = SIGEK(N)                                                      SGP04300
00147         PWR = CPWR+1.0                                                      SGP04400
00150         GO TO 40                                                            SGP04500
00151      35 SG1 = SIGAP(N+1)                                                    SGP04600
00152         SG2 = SIGAP(N)                                                      SGP04700
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00153          PWR = MPWR+1.0
00154       40 IF (N .EQ. 1) GO TO 42
00156          S = S+(ZH-Z(N))*(((SG1-SG2)/(Z(N+1)-Z(N)))*(ZH-Z(N))+SG2)*0.5
00157       42 SIG = (S+(SG3*(HHNK**PWR-ZRK**PWR)/(PWR*(HHNK-ZRK)*ZRK**(PWR-1.0
00157         1)))))*(RAD/HHRK)
00160          RETURN
00161          ENTRY UBARS(ZH,N,IZ,UBHK)
00161    C     SUBROUTINE UBARS CALCULATES UBARNK, X NK, Y NK, CAP THETA (ANG)
00163          XBARX = 0.0
00164          YBARY(IZ) = 0.0
00165          VV = VS(II)
00166          PWR = PPWR+1.0
00167          IF (JF .EQ. 2) VV = VB(II)
00171          IF (N .EQ. 1) GO TO 50
00173          MN = N-1
00174          DO 45 M=1,MN
00177          S1 = SIN(DTHK(M+1))-SIN(DTHK(M))
00200          S2 = COS(DTHK(M+1))-COS(DTHK(M))
00201          S = UBAR(M)/(VV*(DTHK(M+1)-DTHK(M))/(Z(M+1)-Z(M)))
00202          XBARX = XBARX+(S1*S)
00203          YBARY(IZ) = YBARY(IZ)+(S2*(-S))
00204       45 CONTINUE
00206       50 TMPQ1 = 1.0/(Z(N+1)-Z(N))
00207          S = ((DTHK(N+1)-DTHK(N))*TMPQ1)*(ZH-Z(N))+DTHK(N)
00210          S1 = SIN(S)-SIN(DTHK(N))
00211          S2 = COS(S)-COS(DTHK(N))
00212          IF (N .EQ. 1) GO TO 52
00214          UBHK = ((UBARK(N+1)-UBARK(N))*TMPQ1)*0.5*(ZH-Z(N))+(0.5*UBARK(N))
00215          GO TO 54
00216       52 UBHK = (UBARK(1)*(ZH**PWR-ZRK**PWR))/(PWR*(ZH-ZRK)*ZRK**(PWR-1.0))
00217       54 S = UBHK/(VV*(DTHK(N+1)-DTHK(N))*TMPQ1)
00220          XBARX = XBARX+(S1*S)
00221          YBARY(IZ) = YBARY(IZ)+(S2*(-S))
00222          ANG(IZ) = ATAN(YBARY(IZ)/XBARX)
00223          IF (XBARX .GE. 0.0) GO TO 60
00225          IF (YBARY(IZ) .GE. 0.0) GO TO 56
00227          ANG(IZ) = ANG(IZ)-3.1415926536
00230          GO TO 60
00231       56 ANG(IZ) = ANG(IZ)+3.1415926536
00232       60 SQBAR = SQRT(XBARX*XBARX+YBARY(IZ)*YBARY(IZ))
00233          UBARNK(IZ) = SQBAR*VV/ZH
00234          RETURN
00235          ENTRY DEPSO(X,N,IZ)
00235    C     SUBROUTINE DEPSO CALCULATES ALL OF THE DEPOSITION EQUATION EXCEPT
00235    C     THE LATERAL TERM
00237          ZH = ZZL(IZ)
00240          VV = VS(II)
00241          XXX = X
00242          PERK = PERC(II)
00243          IF (JF .EQ. 1) GO TO 65
00245          ZH = HB
00246          VV = VB(II)
00247          XXX = X+(SIGZO(N)/SIGENK(IZ))**(1.0/BETANK(IZ))
00250          PERK = PERCD(II)
00251          T(N) = 1.0
00252       65 S3 = VV*XXX/UBARNK(IZ)
00253          S2 = 1.0/(SIGENK(IZ)*XXX**BETANK(IZ))
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00254    105*          S1 = EXP(-0.5*((S3-ZH)*S2)**2)                                    SGP10500
00255    106*          S2 = EXP(-0.5*((ZH-(2.0*Z(N+1))-S3)*S2)**2)                       SGP10600
00256    107*          XKNK = SIGENK(IZ)*XXX**(BETANK(IZ)+1.0)                           SGP10700
00257    108*          XJNK = (((1.0-BETANK(IZ))*S3+BETANK(IZ)*ZH)/XKNK)*S1              SGP10800
00260    109*          XKNK = ((2.0*BETANK(IZ)*Z(N+1)-BETANK(IZ)*ZH-(1.0-BETANK(IZ))*S3)/SGP10900
00260    110*         1XKNK)*S2                                                          SGP11000
00261    111*          XY = (SIGYO(N)/SIGANK(IZ))**(1.0/ALPHNK(IZ))                      SGP11100
00262    112*          SIGYNK = SQRT((SIGANK(IZ)*(X+XY)**ALPHNK(IZ))**2+(SIGENK(IZ)*XXX**SGP11200
00262    113*         1BETANK(IZ)*YDARY(IZ)/ZH)**2)                                      SGP11300
00263    114*          DEP = (Q(N)*PERK*T(N)/(6.2831853072*SIGYNK*FLOAT(NXCI)))*(XJNK+   SGP11400
00263    115*         1XKNK)                                                             SGP11500
00264    116*          RETURN                                                            SGP11600
00265    117*          ENTRY BETAK(ZH,N,IZ)                                              SGP11700
00265    118*    C     SUBROUTINE BETAK CALCULATES  BETA NK AND ALPHA NK                 SGP11800
00267    119*          S1 = 0.0                                                          SGP11900
00270    120*          S2 = 0.0                                                          SGP12000
00271    121*          IF (N .EQ. 1) GO TO 90                                            SGP12100
00273    122*          MN = N-1                                                          SGP12200
00274    123*          DO 70 M=1,MN                                                      SGP12300
00277    124*          S1 = S1+BETA(M)*(Z(M+1)-Z(M))                                     SGP12400
00300    125*          S2 = S2+ALPHA(M)*(Z(M+1)-Z(M))                                    SGP12500
00301    126*       70 CONTINUE                                                          SGP12600
00303    127*          TMPQ1 = 1.0/ZH                                                    SGP12700
00304    128*          TMPQ2 = ZH-Z(N)                                                   SGP12800
00305    129*          BETANK(IZ) = (S1+BETA(N)*TMPQ2)*TMPQ1                             SGP12900
00306    130*          ALPHNK(IZ) = (S2+ALPHA(N)*TMPQ2)*TMPQ1                            SGP13000
00307    131*          GO TO 95                                                          SGP13100
00310    132*       90 BETANK(IZ) = BETA(N)                                              SGP13200
00311    133*          ALPHNK(IZ) = ALPHA(N)                                             SGP13300
00312    134*       95 CONTINUE                                                          SGP13400
00313    135*          RETURN                                                            SGP13500
00314    136*          END                                                               SGP13600

     END OF COMPILATION:        NO  DIAGNOSTICS.
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@FOR,US COORD
FOR C10L-03/14/73-21:37:41 (0,1)

   SUBROUTINE COORD       ENTRY POINT 001507

   STORAGE USED: CODE(1) 001615; DATA(0) 000060; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003   PARAMT 002173
    0004   PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005   EL
    0006   SIGMA
    0007   COS
    0010   SQRT
    0011   ACOS
    0012   SIN
    0013   NEXP6$
    0014   NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001   000247 100L    0001   000357 110L    0001   000364 120L    0001   000377 130L    0001   000412 140L
    0001   000425 150L    0001   000500 176L    0001   000511 180L    0001   001060 181L    0001   001073 182L
    0001   001145 183L    0001   001161 184L    0001   001164 185L    0001   001200 186L    0001   001204 187L
    0001   000030 20L     0001   001310 200L    0001   001336 260L    0001   001433 280L    0001   001463 285L
    0001   001467 290L    0001   001471 300L    0001   000202 81L     0001   000213 82L     0001   000216 85L
    0001   000231 90L     0001   000234 95L     0003   001725 ACCUR   0000 R 000007 ALP     0003 R 001056 ALPHA
    0003   001777 ALPHL   0004   001510 ALPHNK  0004   001034 ANG     0000 R 000013 B       0003   001114 BETA
    0004   001344 BETANK  0003   002011 BETL    0003   001605 CI      0004   000264 CON     0003   000014 DATE
    0003   001423 DECAY   0000 R 000014 DEL     0003   002172 DELPHI  0004   000074 DELTHP  0004   000226 DELU
    0003 R 000567 DELX    0003 R 000613 DELY    0004   000566 DEP     0004   001656 DEPN    0003   001573 DI
    0000 R 000004 DX      0000 R 000012 DXP     0003   000423 DXR     0000 R 000005 DY      0000 R 000023 GAM
    0003   001203 H       0003   001776 HB      0004   000441 I       0004 I 000454 IDOT    0003   001427 IFLAG
    0004   000665 II      0004   000450 ILK     0000   000037 INJP$   0003   000016 ISKIP   0004 I 000502 ITAG
    0004 I 000453 ITOP    0003   001377 IZMOD   0004 I 000442 J       0003   001631 JBOT    0004 I 000646 JF
    0003   001643 JTOP    0004   000443 KK      0004 R 000437 L       0003 R 001426 LAMBDA  0004   025276 LAT
    0004   000652 LB1     0004   000657 LB2     0004 R 000651 MPWR    0000 I 000021 M1      0003 I 000062 NBK
    0003   000060 NCI     0003   000057 NDI     0003   000061 NDXR    0004   000452 NHZ     0003   000063 NPTS
    0003   000065 NVB     0003   000064 NVS     0004   001655 NXCI    0003   000054 NXS     0003   000055 NYS
    0003   000056 NZS     0004   000432 PEAKO   0003   001701 PERC    0003   001752 PERCB   0000 R 000020 PHI
    0000 R 000025 PHI2    0004   000647 PPWR    0003   000637 Q       0004   000050 QPWR    0004 R 000451 RAD
    0000 R 000015 S       0003   000710 SIGAK   0003   002052 SIGAL   0004   025444 SIGANK  0004 R 000036 SIGAP
    0003   000735 SIGEK   0003   002076 SIGEL   0004   025350 SIGENK  0004   000132 SIGEP   0004 R 000435 SIGX
    0004   000501 SIGXNK  0003   000762 SIGXO   0004 R 000434 SIGY    0004   025277 SIGYNK  0003   001006 SIGYO
    0004   000433 SIGZ    0003   001032 SIGZO   0004   001654 SOBAR   0004   000436 SQR2P   0004   000444 STO1
    0004   000445 STO2    0004   000446 STO3    0003   002146 T       0003   001617 TAST    0003   001201 TAUK
    0003   002023 TAUL    0003   001202 TAUCK   0003   002024 TAUOL   0003 I 000000 TESTNO  0004 R 000440 TH
    0004 R 000170 THETA   0003   001154 THETAK  0003   002122 THETAL  0000 R 000001 THP     0000 R 000000 THPL
    0003   001153 TIMAV   0003   001425 TIM1    0000 R 000010 TMP01   0000 R 000011 TMP02   0000 R 000006 TMP03
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0004 R 000447 TRD       0000 R 000017 T1      0004   000000 UBAR    0003   000663 UBARK   0003   002026 UBARL
0004   001200 UBARNK    0003   001726 VB      0004   000430 VER     0000 R 000022 VP      0004   000431 VREF
0003   001655 VS        0004 R 000455 XAST    0004   001033 XBARX   0000 R 000016 XCI     0003   001231 XLRY
0003   001232 XLRZ      0003 R 001227 XRY     0003   001230 XRZ     0000 R 000024 XSS     0003   000066 XX
0000 R 000002 X1        0004   000667 YBARY   0003   000232 YY      0000 R 000003 Y1      0003   000376 Z
0003   001424 ZLIM      0003   001152 ZRK     0003   002025 ZRL     0003   001233 ZZL

00101          SUBROUTINE COORD(N,M,X,Y,XO,YO,ASP,XS,ICK)                       CRD00100
00103          COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI, CRD00200
00103         1NDXR,NBK,NPTS,NVS,NVR,XX(100),YY(100),Z(21),DXR(100),DELX(20),    CRD00300
00103         2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20), CRD00400
00103         3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)CRD00500
00103         4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,     CRD00600
00103         5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),       CRD00700
00103         6PERC(20),ACCUR,VB(20),PERCB(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL, CRD00800
00103         7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI         CRD00900
00104          COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),CRD01000
00104         1DELU(30),CON(100),VER,VREF,PEAKD,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,CRD01100
00104         2STO1,STO2,STO3,TRD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)CRD01200
00104         3,JF,PPWR,QPWR,MPWR,LB1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100)CRD01300
00104         4UBARNK(100),DETANK(100),ALPHNK(100),SQBAR,NXCI,DEPN(100,100),LAT, CRD01400
00104         5SIGYNK,SIGLNK(100),SIGANK(100)                                   CRD01500
00105          INTEGER TESTNO                                                   CRD01600
00106          REAL MPWR,L,LAMBDA                                               CRD01700
00106   C       *****THIS SUBROUTINE TRANSLATES AND ROTATES THE FIXED INPUT *****CRD01800
00106   C       ***** COORDINATES RELATIVE TO A SYSTEM WITH POSITIVE X AXIS  ****CRD01900
00106   C       ***** ALONG THE WIND DIRECTION THETA. IT ALSO DETERMINES IF  ****CRD02000
00106   C       ***** THE RECEPTOR COORDINATES LY WITHIN AN ANGLE OF ONE-   *****CRD02100
00106   C       *****  HALF DELPHI FROM THETA                                   CRD02200
00107          IF (NBK .EQ. 0) GO TO 20                                         CRD02300
00107   C      DETERMINE ANGLE TO CLOUD AXIS                                    CRD02400
00111          IF (THETA(JF) .GE. 180.0) THPL = (THETA(JF)-180.0)*RAD           CRD02500
00113          IF (THETA(JF) .LT. 180.0) THPL = (THETA(JF)+180.0)*RAD           CRD02600
00115       20 IF (THETA(M) .GE. 180.0) THP = (THETA(M)-180.0)*RAD              CRD02700
00117          IF (THETA(M) .LT. 180.0) THP = (THETA(M)+180.0)*RAD              CRD02800
00121          TH = THETA(M)*RAD                                                CRD02900
00122       40 X1 = XO                                                          CRD03000
00123          Y1 = YO*RAD                                                      CRD03100
00124          DX = DELX(M)                                                     CRD03200
00125          DY = DELY(M)*RAD                                                 CRD03300
00126       60 IF (ICK .NE. 2) GO TO 100                                        CRD03400
00126   C      DETERMINE LOCATION OF IMAGINARY SOURCE FOR LAYER CHANGE          CRD03500
00130          TMPQ3 = TH-DY                                                    CRD03600
00131          ALP = ABS(TMPQ3)                                                 CRD03700
00132          IF (ALP .GT. 3.1415926536) ALP = 6.2831853072-ALP                CRD03800
00134          TMPQ1 = XAST(M)*XAST(M)                                          CRD03900
00135          TMPQ2 = DX*DX                                                    CRD04000
00136          DXP = SQRT(TMPQ1+TMPQ2-2.0*XAST(M)*DX*COS(ALP))                  CRD04100
00137          B = (DXP*DXP+TMPQ1-TMPQ2)/(2.0*DXP*XAST(M))                      CRD04200
00140          IF (B .GT. 1.0) B = 1.0                                          CRD04300
00142          IF (B .LT. -1.0) B = -1.0                                        CRD04400
00144          DEL = ACOS(B)                                                    CRD04500
00145          DX = DXP                                                         CRD04600
00146          IF (DXP-0.0) 81,,81                                              CRD04700
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00151     48*            DY = 0.0                                                    CRD04800
00152     49*            GO TO 100                                                   CRD04900
00153     50*         81 CONTINUE                                                    CRD05000
00154     51*            IF (ALP .GT. 3.1415926536) GO TO 82                         CRD05100
00156     52*            IF (TMP03) 85,90,95                                         CRD05200
00161     53*         82 IF (TMP03) 95,90,85                                         CRD05300
00164     54*         85 DY = THP-DEL                                                CRD05400
00165     55*            IF (DY .LT. 0.0) DY = 6.2831853072+DY                       CRD05500
00167     56*            GO TO 100                                                   CRD05600
00170     57*         90 DY = THP                                                    CRD05700
00171     58*            GO TO 100                                                   CRD05800
00172     59*         95 DY = THP+DEL                                                CRD05900
00173     60*            IF (DY .GE. 6.2831853072) DY = DY-6.2831853072              CRD06000
00173     61*     C      DETERMINE ANGLE AND DISTANCE OF CALCULATION GRID POINT      CRD06100
00173     62*     C      RELATIVE TO SOURCE                                          CRD06200
00175     63*        100 S = ABS(Y1-DY)                                              CRD06300
00176     64*            IF (S .GT. 3.1415926536) S = 6.2831853072-S                 CRD06400
00200     65*            TMP01 = X1*X1                                               CRD06500
00201     66*            TMP02 = DX*DX                                               CRD06600
00202     67*            XS = SQRT(TMP01+TMP02-2.0*X1*DX*COS(S))                     CRD06700
00203     68*            B = (TMP01+XS*XS-TMP02)/(2.0*X1*XS)                         CRD06800
00204     69*            IF (B .GT. 1.0) B = 1.0                                     CRD06900
00206     70*            IF (B .LT. -1.0) B = -1.0                                   CRD07000
00210     71*            XCI = ACOS(B)                                               CRD07100
00211     72*            IF (ABS(Y1-DY) .GT. 3.1415926536) GO TO 110                 CRD07200
00213     73*            IF (Y1-DY) 130,120,140                                      CRD07300
00216     74*        110 IF (Y1-DY) 140,120,130                                      CRD07400
00221     75*        120 ASP = Y1                                                    CRD07500
00222     76*            IF (XCI .GT. 3.0) ASP = ASP+3.1415926536                    CRD07600
00224     77*            GO TO 150                                                   CRD07700
00225     78*        130 ASP = Y1-XCI                                                CRD07800
00226     79*            IF (ASP .LT. 0.0) ASP = 6.2831853072+ASP                    CRD07900
00230     80*            GO TO 150                                                   CRD08000
00231     81*        140 ASP = Y1+XCI                                                CRD08100
00232     82*            IF (ASP .GE. 6.2831853072) ASP = ASP-6.2831853072           CRD08200
00234     83*        150 CONTINUE                                                    CRD08300
00235     84*            T1 = THP                                                    CRD08400
00236     85*            IF (ICK .EQ. 2) T1 = THPL                                   CRD08500
00240     86*        170 PHI = ABS(ASP-T1)                                           CRD08600
00241     87*            IF (PHI .GT. 3.1415926536) PHI = 6.2831853072-PHI           CRD08700
00241     88*     C      IF NOT A LAYER CHANGE PROBLEM DETERMINE IF CALCULATION POINT IS CRD08800
00241     89*     C      WITHIN CALCULATION SECTOR                                   CRD08900
00243     90*            IF (NEK .NE. 0.AND.IBOT .LE. M.AND.M .LE. ITOP) GO TO 180   CRD09000
00243     91*     C      IF (POINT WITHIN SECTOR BRANCH                              CRD09100
00245     92*        175 IF (PHI .LE. TRD) GO TO 280                                 CRD09200
00247     93*        176 N = 9                                                       CRD09300
00247     94*     C      POINT OUTSIDE SECTOR SET FLAG TO 9                          CRD09400
00250     95*            ITAG(J) = 9                                                 CRD09500
00251     96*            X = XS                                                      CRD09600
00252     97*            RETURN                                                      CRD09700
00252     98*     C      THIS IS A LAYER CHANGE PROBLEM                              CRD09800
00253     99*        180 CALL EL(XAST(M),M)                                          CRD09900
00254    100*            CALL SIGMA(XAST(M),0,M)                                     CRD10000
00255    101*            M1 = JF                                                     CRD10100
00256    102*            DEL = ABS(THP-THPL)                                         CRD10200
00257    103*            IF (DEL .GE. 3.1415926) DEL = 6.2831853-DEL                 CRD10300
00257    104*     C      CALCULATE VIRTUAL POINT                                     CRD10400
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00261          VP = ALPHA(M1)*XRY*((SQRT((SIGX*SIN(DEL))**2+(SIGY*COS(DEL))**2))/CRD10500
00261         1(SIGAP(M1)*XRY))**(1.0/ALPHA(M1))+XRY*(1.0-ALPHA(M1))           CRD10600
00262          IF (VP .LE. 1.0) VP = 1.0                                       CRD10700
00264          IF (ICK .EQ. 2) GO TO 260                                       CRD10800
00264    C     DETERMINE IF POINT LIES IN AREA BEFORE OR AFTER LAYER CHANGE    CRD10900
00266          DY = VP/COS(TRD)                                                CRD11000
00267          DX = DY*SIN(TRD)                                                CRD11100
00270          B = DEL                                                         CRD11200
00271          IF (DEL .GE. 1.5707963) B = 3.1415926-DEL                       CRD11300
00273          B = B+1.5707963                                                 CRD11400
00274          TMPQ1 = XAST(M)*XAST(M)                                         CRD11500
00275          DY = SQRT(TMPQ1+DX*DX-2.0*XAST(M)*DX*COS(B))                    CRD11600
00276          IF (XS .GT. DY) GO TO 176                                       CRD11700
00300          IF (PHI .GT. TRD) GO TO 176                                     CRD11800
00302          TMPQ2 = XS*XS                                                   CRD11900
00303          DXP = SQRT(TMPQ2+TMPQ1-2.0*XS*XAST(M)*COS(PHI))                 CRD12000
00304          B = ((DXP*DXP+TMPQ1-TMPQ2)/(2.0*DXP*XAST(M)))                   CRD12100
00305          IF (B .GT. 1.0) B = 1.0                                         CRD12200
00307          IF (B .LT. -1.0) B = -1.0                                       CRD12300
00311          B = ACOS(B)                                                     CRD12400
00312          S = ABS(ASP-THP)                                                CRD12500
00313          IF (DEL .GE. 1.5707963) GO TO 182                               CRD12600
00315          IF (THPL-THP) ,179, 184,179                                     CRD12700
00320      179 IF (THPL .GT. THP.AND.ABS(THPL-THP) .LT. 3.1415926) GO TO 181   CRD12800
00322          IF (THP .GT. THPL.AND.ABS(THPL-THP) .GT. 3.1415926) GO TO 181   CRD12900
00324          IF (ASP .LT. THP) GO TO 185                                     CRD13000
00326          IF (S .GE. 3.1415926) GO TO 185                                 CRD13100
00330          GO TO 186                                                       CRD13200
00331      181 IF (ASP .GT. THP) GO TO 185                                     CRD13300
00333          IF (S .GE. 3.1415926) GO TO 185                                 CRD13400
00335          GO TO 186                                                       CRD13500
00336      182 IF (THPL .GT.THP .AND.ABS(THPL-THP) .GT. 3.1415926) GO TO 183   CRD13600
00340          IF (THP .GT. THPL.AND.ABS(THPL-THP) .LT. 3.1415926) GO TO 183   CRD13700
00342          IF (ASP .LT. THP) GO TO 186                                     CRD13800
00344          IF (S .GE. 3.1415926) GO TO 186                                 CRD13900
00346          GO TO 185                                                       CRD14000
00347      183 IF (ASP .GT. THP) GO TO 186                                     CRD14100
00351          IF (S .GE. 3.1415926) GO TO 186                                 CRD14200
00353          GO TO 185                                                       CRD14300
00354      184 GAM = B                                                         CRD14400
00355          GO TO 187                                                       CRD14500
00356      185 GAM = DEL+B                                                     CRD14600
00357          IF (GAM .GE. 3.1415926) GAM = 6.2831853-GAM                     CRD14700
00361          GO TO 187                                                       CRD14800
00362      186 GAM = ABS(DEL-B)                                                CRD14900
00363      187 TMPQ1 = DXP*DXP                                                 CRD15000
00364          TMPQ2 = VP*VP                                                   CRD15100
00365          XSS = SQRT(TMPQ1+TMPQ2-2.0*DXP*VP*COS(GAM))                     CRD15200
00366          B = ((TMPQ2+XSS*XSS-TMPQ1)/(2.0*VP*XSS))                        CRD15300
00367          IF (B .GT. 1.0) B = 1.0                                         CRD15400
00371          IF (B .LT. -1.0) B= -1.0                                        CRD15500
00373          PHI2 = ACOS(B)                                                  CRD15600
00374          IF (DEL .GE. 1.5707963) GO TO 200                               CRD15700
00376          IF (XSS*B .GT. VP.AND.PHI2 .LE. TRD) GO TO 176                  CRD15800
00400          GO TO 280                                                       CRD15900
00401      200 IF (XSS*B .LE. VP.OR.PHI2.GT. TRD) GO TO 280                    CRD16000
00401    C     IF POINT LIES IN CALCULATION SECTOR AND OCCURS BEFORE LAYER     CRD16100
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00401   C      CHANGE BRANCH TO 280 OTHERWISE RETURN CODE FLAG 9                 CRD16200
00403          IF (XS .LE. XAST(M)) GO TO 280                                    CRD16300
00405          GO TO 176                                                         CRD16400
00405   C      POINT OCCURS IN AREA AFTER LAYER CHANGE                           CRD16500
00406      260 TMPQ1 = VP*VP                                                     CRD16600
00407          TMPQ2 = XS*XS                                                     CRD16700
00410          XSS = SQRT(TMPQ1+TMPQ2-2.0*VP*XS*COS(3.1415926-PHI))              CRD16800
00411          B = ((TMPQ1+XSS*XSS-TMPQ2)/(2.0*VP*XSS))                          CRD16900
00412          IF (B .GT. 1.0) B = 1.0                                           CRD17000
00414          IF (B .LT. -1.0) B = -1.0                                         CRD17100
00416          PHI2 = ACOS(B)                                                    CRD17200
00416   C      IF POINT IS NOT WITHIN CALCULATION SECTOR BRANCH TO 176 AND RETURNCRD17300
00416   C      CODE 9                                                            CRD17400
00417          IF (PHI2 .GT. TRD) GO TO 176                                      CRD17500
00421          IF (VP .GT. XSS*B) GO TO 176                                      CRD17600
00421   C      CALCULATE LOCATION OF POINT RELATIVE TO SOURCE OR RELATIVE TO     CRD17700
00421   C      IMAGINARY SOURCE BEYOND REAL SOURCE DUE TO LAYER CHANGE           CRD17800
00423      280 X = XS*COS(PHI)                                                   CRD17900
00424          IF (X) 176,176,282                                                CRD17950
00427      282 Y = XS*SIN(PHI)                                                   CRD18000
00430          IF (ABS(ASP-T1) .GT. 3.1415926) GO TO 285                         CRD18100
00432          IF (ASP-T1) 290,300,300                                           CRD18200
00435      285 IF (ASP-T1) 300,300,290                                           CRD18300
00440      290 Y = -Y                                                            CRD18400
00441      300 CONTINUE                                                          CRD18500
00442          ITAG(J) = 0                                                       CRD18600
00443          N = 0                                                             CRD18700
00444          RETURN                                                            CRD18800
00445          END                                                               CRD18900
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END OF COMPILATION: NO DIAGNOSTICS.

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@FOR,US SIGMA
FOR C10L-03/14/73-21:37:45 (0,1)

 SUBROUTINE SIGMA      ENTRY POINT 000454

 STORAGE USED: CODE(1) 000472; DATA(0) 000034; BLANK COMMON(2) 000000

  COMMON BLOCKS:

  0003   PARAMT 002173
  0004   PARAMS 025610

 EXTERNAL REFERENCES (BLOCK, NAME)

  0005   NEXP6$
  0006   NERR2$
  0007   SQRT
  0010   COS
  0011   SIN
  0012   NERR3$

 STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

  0001   000106 10L     0001   000114 20L     0001   000203 24L     0001   000226 25L     0001   000262 30L
  0001   000006 4L      0001   000267 40L     0001   000013 5L      0001   000017 6L      0001   000442 60L
  0001   000040 8L      0001   000063 9L      0003   001725 ACCUR   0003 R 001056 ALPHA   0000 R 000001 ALPHAP
  0003   001777 ALPHL   0004   001510 ALPHNK  0004   001034 ANG     0003 R 001114 BETA    0004   001344 BETANK
  0000 R 000002 BETAP   0003   002011 BETL    0003   001605 CI      0004   000264 CON     0003   000014 DATE
  0003   001423 DECAY   0003   002172 DELPHI  0004 R 000074 DELTHP  0004   000226 DELU    0003   000567 DELX
  0003   000613 DELY    0004   001666 DEP     0004   001656 DEPN    0003   001573 DI      0003   000423 DXR
  0003   001203 H       0003   001776 HU      0004   000441 I       0004   000454 IBOT    0003   001427 IFLAG
  0004   000665 II      0004   000450 ILK     0000   000014 INJP$   0000 I 000000 ISAVE   0003   000016 ISKIP
  0004   000502 ITAG    0004   000453 ITOP    0003 I 001377 IZMOD   0004   000442 J       0003   001631 JBOT
  0004 I 000646 JF      0003   001643 JTOP    0004 I 000443 KK      0004 R 000437 L       0003 R 001426 LAMBDA
  0004   025276 LAT     0004   000652 LB1     0004   000657 LB2     0004 R 000651 MPWR    0000 I 000004 N
  0003   000062 NBK     0003   000060 NCI     0003   000057 NDI     0003   000061 NDXR    0004   000452 NNZ
  0003   000063 NPTS    0003   000065 NVB     0003   000064 NVS     0004   001555 NXCI    0003   000054 NXS
  0003   000055 NYS     0003   000056 NZS     0004   000432 PEAKD   0003   001701 PERC    0003   001752 PERCB
  0004   000647 PPWR    0003   000637 C       0004   000650 QPWR    0004 R 000451 RAD     0003   000710 SIGAK
  0003   002052 SIGAL   0004   025444 SIGANK  0004 R 000036 SIGAP   0003   000735 SIGEK   0003   002076 SIGEL
  0004   025300 SIGENK  0004 R 000132 SIGEP   0004 R 000435 SIGX    0004 R 000501 SIGXNK  0003 R 000762 SIGXO
  0004 R 000434 SIGY    0004 R 025277 SIGYNK  0003 R 001006 SIGYO   0004 R 000433 SIGZ    0003 R 001032 SIGZO
  0004 R 001654 SUBAR   0004   000436 SQR2P   0004   000444 STO1    0004   000445 STO2    0004   000446 STO3
  0003   002146 T       0003   001617 TAST    0003   001201 TAUK    0003   002023 TAUL    0003   001202 TAUOK
  0003   002024 TAUOL   0003 I 000000 TESTNO  0004   000440 TH      0004 R 000170 THETA   0003   001154 THETAK
  0003   002122 THETAL  0003   001153 TIMAV   0003   001425 TIM1    0000 R 000010 TMP01   0004   000447 TRD
  0000 R 000005 T1      0000 R 000006 T2      0004   000000 UBAR    0003   000663 UBARK   0003   002026 UBARL
  0004   001200 UBARNK  0003   001726 VB      0004   000430 VER     0004   000431 VREF    0003   001655 VS
  0004   000455 XAST    0004   001033 XBARK   0003 R 001231 XLRY    0003 R 001232 XLRZ    0003 R 001227 XRY
  0003 R 001230 XRZ     0003   000066 XX      0000 R 000003 XY      0000 R 000007 XZ      0004   000667 YBARY
  0003   000232 YY      0003   000376 Z       0003   001424 ZLIM    0003   001152 ZRK     0003   002025 ZRL
  0003   001233 ZZL
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00101         SUBROUTINE SIGMA(X,M,MM)                                           SGA00100
00103         COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI,  SGA00200
00103        1NDXR,NBK,NPTS,NVS,NVB,XX(100),YY(100),Z(21),DXR(100),DELX(20),     SGA00300
00103        2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGFK(21),SIGXO(20),SIGYO(20),  SGA00400
00103        3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)SGA00500
00103        4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,      SGA00600
00103        5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),        SGA00700
00103        6PERC(20),ACCUR,VB(20),PERCB(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL,  SGA00800
00103        7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI          SGA00900
00104         COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),SGA01000
00104        1DELU(30),CON(100),VER,VREF,PEAKD,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,SGA01100
00104        2STO1,STO2,STO3,TRD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)SGA01200
00104        3,JF,PPWR,QPWR,MPWR,LB1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),SGA01300
00104        4UBARNK(100),BETANK(100),ALPHNK(100),SQBAR,NXCI,DEPN(100,100),LAT,  SGA01400
00104        5SIGYNK,SIGLNK(100),SIGANK(100)                                     SGA01500
00105         INTEGER TESTNO                                                     SGA01600
00106         REAL MPWR,L,LAMBDA                                                 SGA01700
00106   C     ***** THIS SUBROUTINE CALCULATES THE STANDARD DEVIATIONS OF X,Y,ZSGA01800
00107         IF (MM .GT. 0) GO TO 4                                             SGA01900
00111         GO TO 5                                                            SGA02000
00112       4 ISAVE = KK                                                         SGA02100
00113         KK = MM                                                            SGA02200
00114         GO TO 6                                                            SGA02300
00115       5 IF (M .GT. 0) GO TO 40                                             SGA02400
00117       6 CONTINUE                                                           SGA02500
00120         ALPHAP = 1.0/ALPHA(KK)                                             SGA02600
00121         BETAP = 1.0/BETA(KK)                                               SGA02700
00122         IF (SIGYO(KK)-SIGAP(KK)*XRY) 7,7,8                                 SGA02800
00125       7 XY = SIGYO(KK)/SIGAP(KK)-XLRY                                      SGA02900
00126         GO TO 9                                                            SGA03000
00127       8 XY = ALPHA(KK)*XRY*(SIGYO(KK)/(SIGAP(KK)*XRY))**ALPHAP-XLRY+XRY*   SGA03100
00127        1(1.0-ALPHA(KK))                                                    SGA03200
00130       9 CONTINUE                                                           SGA03300
00131         IF (XY .LT. 0.0) XY = 0.0                                          SGA03350
00133         N = IZMOD(KK)                                                      SGA03400
00134         GO TO (20,10,20),N                                                 SGA03500
00135      10 SIGY = SIGYO(KK)                                                   SGA03600
00136         SIGX = SIGXO(KK)                                                   SGA03700
00137         GO TO 30                                                           SGA03800
00140      20 T1 = SIGAP(KK)*XRY*((X+XY-XRY*(1.0-ALPHA(KK)))/(XRY*ALPHA(KK)))** SGA03900
00140        1ALPHA(KK)                                                          SGA04000
00141         T2 = (ABS(DELTHP(KK))*RAD*X*.23255814)**2                          SGA04100
00142         SIGY = SQRT(T1*T1+T2)                                              SGA04200
00143         SIGX = SQRT((L*L*.05406329)+SIGXO(KK)*SIGXO(KK))                   SGA04300
00144         IF (SIGZO(KK)-SIGEP(KK)*XRZ) 22,22,24                              SGA04400
00147      22 XZ = SIGZO(KK)/SIGEP(KK)-XLRZ                                      SGA04500
00150         GO TO 25                                                           SGA04600
00151      24 XZ = BETA(KK)*XRZ*(SIGZO(KK)/(SIGEP(KK)*XRZ))**BETAP-XLRZ+XRZ*     SGA04700
00151        1(1.0-BETA(KK))                                                     SGA04800
00152      25 CONTINUE                                                           SGA04900
00153         IF (XZ .LT. 0.0) XZ = 0.0                                          SGA04950
00155         SIGZ = SIGEP(KK)*XRZ*((X+XZ-XRZ*(1.0-BETA(KK)))/(BETA(KK)*XRZ))** SGA05000
00155        1BETA(KK)                                                           SGA05100
00156      30 IF (MM .EQ. 0) GO TO 60                                            SGA05200
00160         KK = ISAVE                                                         SGA05300
00161         GO TO 63                                                           SGA05400
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00162       40 TMPQ1 = (THETA(M)-THETA(JF))*RAD                                      SGA05500
00163          SIGYNK = SQRT((SIGX*SIN(TMPQ1))**2+(SIGY*COS(TMPQ1))**2)              SGA05600
00164          SQBAR = ALPHA(JF)*XRY*(SIGYNK/(SIGAP(JF)*XRY))**(1.0/ALPHA(JF))+      SGA05700
00164         1XRY*(1.0-ALPHA(JF))                                                   SGA05800
00165          SIGYNK = SQRT((SIGAP(JF)*XRY*((X+SQBAR-XRY*(1.0-ALPHA(JF)))/          SGA05900
00165         1(ALPHA(JF)*XRY))**ALPHA(JF))**2+((ABS(DELTHP(JF))*RAD*.23255814)      SGA06000
00165         2*X)**2)                                                               SGA06100
00166          SIGZ = SIGEP(JF)*XRZ*(X/XRZ)**BETA(JF)                                SGA06200
00167          SQBAR = SQRT((SIGX*COS(TMPQ1))**2+(SIGY*SIN(TMPQ1))**2)               SGA06300
00170          SIGXNK = SQRT((L*L*.05408329)+SQBAR*SQBAR)                            SGA06400
00170    C     .23255814 IS 1.0/4.3 AND .05408329 IS (1.0/4.3)**2                    SGA06500
00171       60 CONTINUE                                                              SGA06600
00172          RETURN                                                                SGA06700
00173          END                                                                   SGA06800

     END OF COMPILATION:        NO  DIAGNOSTICS.
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@FOR,US VERT
FOR 010L-03/14/73-21:37:48 (0,1)

   SUBROUTINE VERT      ENTRY POINT 000207

   STORAGE USED: CODE(1) 000216; DATA(0) 000025; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003    PARAMT 002173
    0004    PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005    NERR2$
    0006    EXP
    0007    NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001    000054 30L     0001    000064 40L     0001    000016 5L      0001    000157 50L     0001    000161 60L
    0001    000171 70L     0001    000175 80L     0003    001725 ACCUR   0003    001056 ALPHA   0003    001777 ALPHL
    0004    001510 ALPHNK  0004    001034 ANG     0003    001114 BETA    0004    001344 BETANK  0003    002011 BETL
    0003    001605 CI      0004    000264 CON     0003    000014 DATE    0003    001423 DECAY   0003    002172 DELPHI
    0004    000074 DELTHP  0004    000226 DELU    0003    000567 DELX    0003    000613 DELY    0004    000666 DEP
    0004    001656 DEPN    0003    001573 DI      0003    000423 DXR     0003 R  001203 H       0003    001776 HB
    0004    000441 I       0004    000454 IBOT    0003    001427 IFLAG   0004    000665 II      0004    000450 ILK
    0000    000011 INJPS   0003    000015 ISKIP   0004    000502 ITAG    0004    000453 ITOP    0003 I  001377 IZMOD
    0004    000442 J       0003    001631 JBOT    0004    000646 JF      0003    001643 JTOP    0004 I  000443 KK
    0004 R  000437 L       0003 R  001426 LAMBDA  0004    025276 LAT     0004    000652 LB1     0004    000657 LB2
    0004 R  000651 MPWR    0000 I  000000 N       0003    000062 NPK     0003    000060 NCI     0003    000057 NDI
    0003    000061 NOXR    0004    000452 NNZ     0003    000063 NPTS    0003    000065 NVB     0003    000064 NVS
    0004    001655 NXCI    0003    000054 NXS     0003    000055 NYS     0003    000056 NZS     0004    000432 PEAKD
    0003    001701 PERC    0003    001752 PEPCB   0004    000647 PPWR    0003    000637 O       0004    000650 GPWR
    0004    000451 RAD     0003    000710 SIGAK   0003    002052 SIGAL   0004    025444 SIGANK  0004    000036 SIGAP
    0003    000735 SIGEK   0003    002076 SIGEL   0004    025300 SIGENK  0004    000132 SIGEP   0004    000435 SIGX
    0004    000501 SIGXNK  0003    000762 SIGXO   0004    000434 SIGY    0004    025277 SIGYNK  0003    001006 SIGYO
    0004 R  000433 SIGZ    0003    001032 SIGZO   0004    001654 SCBAR   0004    000436 SCR2P   0004    000444 STO1
    0004 R  000445 STO2    0004 R  000446 STO3    0003    002146 T       0003    001617 TAST    0003    001201 TAUK
    0003    002023 TAUL    0003    001202 TAUOK   0003    002024 TAUOL   0003 I  000000 TESTNO  0004    000440 TH
    0004    000170 THETA   0003    001154 THETAK  0003    002122 THETAL  0000 R  000002 TI      0003    001153 TIMAV
    0003    001425 TIM1    0000 R  000004 TLIM    0000 R  000001 TMPG1   0000 R  000003 TR      0004    000447 TRD
    0004    000000 UBAR    0003    000663 UBARK   0003    002026 UPARL   0004    001200 UBARNK  0003    001726 VB
    0004 R  000430 VER     0004 R  000431 VREF    0003    001655 VS      0004    000455 XAST    0004    001033 XBARX
    0003    001231 XLRY    0003    001232 XLPZ    0003    001227 XRY     0003    001230 XRZ     0003    000066 XX
    0004    000067 YBARY   0003    001232 YY      0003 R  000376 Z       0003    001424 ZLIM    0003    001152 ZPK
    0003    002025 ZKL     0003 R  001233 ZZL


00101      1*          SUBROUTINE VERT(K,NN)                                          VRT00100
00103      2*          COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI,  VRT00200
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00103          1NDXR,NBK,NPTS,NVS,NVP,XX(100),YY(100),Z(21),DXR(100),DELX(20),     VRT00300
00103          2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20),   VRT00400
00103          3SIGZO(20),ALPHA(30),BETA(30),ZPK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)VRT00500
00103          4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,       VRT00600
00103          5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),         VRT00700
00103          6PERC(20),ACCUR,VR(20),PERCB(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL,   VRT00800
00103          7ZBL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI          VRT00900
00104           COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTMP(30),SIGEP(30),THETA(30),VRT01000
00104          1DELU(30),CON(100),VER,VREF,PEAKD,SIGZ,SIGY,SIGX,SCR2P,L,TH,I,J,KK,VRT01100
00104          2ST01,ST02,ST03,TRD,ILK,RAD,NNZ,ITOP,IBOT,KAST(20),SIGXNK,ITAG(100)VRT01200
00104          3,JP,PPWR,GPWR,MPWR,LB1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),VRT01300
00104          4UBARNK(100),BETANK(100),ALPHNK(100),SGBAR,NXCI,DEPN(100,100),LAT,  VRT01400
00104          5SIGYNK,SIGENK(100),SIGANK(100)                                     VRT01500
00105           INTEGER TESTNO                                                     VRT01600
00106           REAL MPWR,L,LAMBDA                                                 VRT01700
00106     C      ***** THIS SUBROUTINE CALCULATES VERTICAL AND VERTICAL REFLECTIONVRT01800
00107           ST02 = 0.0                                                         VRT01900
00110           N = IZMOD(KK)                                                      VRT02000
00111           GO TO (50,50,5),N                                                  VRT02100
00112         5 TMPQ1 = -0.5/(SIGZ*SIGZ)                                           VRT02200
00113           ST02 = EXP(TMPQ1*(H(KK)-ZZL(K))**2)+EXP(TMPQ1*(H(KK)-2.0*Z(KK)+ZZLVRT02300
00113          1(K))**2)                                                           VRT02400
00114        10 ST03 = 0.0                                                         VRT02500
00115        20 TI = 0.0                                                           VRT02600
00116        30 TI = TI+1.0                                                        VRT02700
00117           IF (SIGZ) 35,35,40                                                 VRT02800
00122        35 ST03 = 0.0                                                         VRT02900
00123           GO TO 60                                                           VRT03000
00124        40 CONTINUE                                                           VRT03100
00125           TR = 2.0*TI*(Z(KK+1)-Z(KK))                                        VRT03200
00126           TLIM = (((TR-H(KK)+(2.0*Z(KK))-ZZL(K))**2)*TMPQ1)                  VRT03300
00127           IF (-10.0 .GT. TLIM) GO TO 60                                      VRT03400
00131           ST03 = ST03+EXP(TLIM)+EXP(((TR-H(KK)+ZZL(K))**2)*TMPQ1)            VRT03500
00131          1+EXP(((TR+H(KK)-ZZL(K))**2)*TMPQ1)                                 VRT03600
00131          2+EXP(((TR+H(KK)-2.0*Z(KK)+ZZL(K))**2)*TMPQ1)                       VRT03700
00132           GO TO 30                                                           VRT03800
00133        50 ST03 = 1.0                                                         VRT03900
00134        60 GO TO (70,80),NN                                                   VRT04000
00135        70 VER = ST02                                                         VRT04100
00136           VREF = ST03                                                        VRT04200
00137        80 RETURN                                                             VRT04300
00140           END                                                                VRT04400
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END OF COMPILATION: NO DIAGNOSTICS.

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NASA/MSFC MULTILAYER DIFFUSION MODEL, VERSION 2  H E CRAVER CO                                DATE 031473        PAGE    65

@FOR,US ACH
FOR 010L-03/14/73-21:37:50 (0,1)

   SUBROUTINE ACH        ENTRY POINT 000114
              EL         ENTRY POINT 000117
              LATER      ENTRY POINT 000130

   STORAGE USED: CODE(1) 000135; DATA(0) 000013; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003    PARAMT 002173
    0004    PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005    EXP
    0006    NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001    000031 23L       0001    000047 24L       0001    000064 25L       0003    001725 ACCUR     0003    001056 ALPHA
    0003    001777 ALPHL     0004    001510 ALPHNK    0004    001034 ANG       0003    001114 BETA      0004    001344 BETANK
    0003    002011 BETL      0003    001605 CI        0004    000264 CON       0003    000014 DATE      0003    001423 DECAY
    0003    002172 DELPHI    0004    000074 DELTHP    0004 R  000226 DELU      0003    000567 DELX      0003    000613 DELY
    0004    000666 DEP       0004    001656 DEPN      0003    001573 DI        0003    000423 DXR       0003    001203 H
    0003    001776 HB        0004    000441 I         0004    000454 IROT      0003    001427 IFLAG     0004    000665 II
    0004    000450 ILK       0000    000002 INJP$     0003    000016 ISKIP     0004    000502 ITAG      0004    000453 ITOP
    0003    001377 IZMOD     0004    000442 J         0003    001631 JROT      0004 I  000646 JF        0003    001643 JTOP
    0004 I  000443 KK        0004 R  000437 L         0003 R  001426 LAMBDA    0004 R  025276 LAT       0004    000652 LB1
    0004    000657 LB2       0004 R  000651 MPWR      0003    000062 NBK       0003    000060 NCI       0003    000057 NDI
    0003    000061 NDXR      0004    000452 NNZ       0003    000063 NPTS      0003    000065 NVB       0003    000064 NVS
    0004    001655 NXCI      0003    000054 NXS       0003    000055 NYS       0003    000056 NZS       0004    000432 PEAKD
    0003    001701 PERC      0003    001752 PERCB     0004    000647 PPWR      0003    000637 Q         0004    000650 OPWR
    0004    000451 RAD       0003    000710 SIGAK     0003    002052 SIGAL     0004    025444 SIGANK    0004    000036 SIGAP
    0003    000735 SIGEK     0003    002076 SIGEL     0004    025300 SIGENK    0004    000132 SIGEP     0004    000435 SIGX
    0004    000501 SIGXNK    0003    000762 SIGXO     0004 R  000434 SIGY      0004    025277 SIGYNK    0003    001006 SIGYO
    0004    000433 SIGZ      0003    001032 SIGZO     0004    001654 SCBAR     0004    000436 SOR2P     0004    000444 STO1
    0004    000445 STO2      0004    000446 STO3      0003    002146 T         0003    001017 TAST      0003    001201 TAUK
    0003    002023 TAUL      0003    001262 TAUOK     0003    002024 TAUOL     0003 I  000000 TESTNO    0004    000440 TH
    0004    000170 THETA     0003    001154 THETAK    0003    002122 THETAL    0003    001153 TIMAV     0003    001425 TIM1
    0004    000447 TRD       0004 R  000000 UBAR      0003    000663 UBARK     0003    002026 UBARL     0004    001200 UBARNK
    0003    001726 VB        0004    000430 VER       0004    000431 VREF      0003    001655 VS        0004    000455 XAST
    0004    001033 XBARX     0003    001231 XLRY      0003    001232 XLRZ      0003    001227 XRY       0003    001230 XRZ
    0003    000066 XX        0004    000667 YBARY     0003    000232 YY        0003    000376 Z         0003    001424 ZLIM
    0003    001152 ZKK       0003    002025 ZRL       0003    001233 ZZL


00101      1*          SUBROUTINE ACH                                                 ACH00100
00103      2*          COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI,  ACH00200
00103      3*         1NDXR,NBK,NPTS,NVS,NVB,XX(100),YY(100),Z(21),DXR(100),DELX(20),     ACH00300
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00103          2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20), ACH00400
00103          3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)ACH00500
00103          4,XRY,XPZ,XLRY,XLPZ,Z7L(100),IZPOD(20),DECAY,ZLIM,TIM1,LAMBDA,      ACH00600
00103          5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),        ACH00700
00103          6PERC(20),ACCUR,VP(20),PERCD(20),HD,ALPHL(10),BETL(10),TAUL,TAUOL,  ACH00800
00103          7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI          ACH00900
00104           COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),ACH01000
00104          1DELU(30),CON(100),VER,VREF,PEAKD,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,ACH01100
00104          2ST01,ST02,ST03,TRD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXUK,ITAG(100)ACH01200
00104          3,JF,PPWR,QPWR,MPWR,LP1(5),LU2(6),II,DEP,YBARY(100),XBARY,ANG(100),ACH01300
00104          4UBARNK(100),BETANK(100),ALPHNK(100),SOBAR,NXCI,DEPN(100,100),LAT,  ACH01400
00104          5SIGYNK,SIGLNK(100),SIGANK(100)                                     ACH01500
00105           INTEGER TESTNO                                                     ACH01600
00106           REAL MPWR,L,LAT,LAMBDA                                             ACH01700
00106     C     **** THIS SUBROUTINE CALCULATES L                                  ACH01800
00106     C     **** AND LATERAL TERM                                              ACH01900
00107        20 RETURN                                                             ACH02000
00110           ENTRY EL(X,M)                                                      ACH02100
00112           IF (M .GT. 0) GO TO 24                                             ACH02200
00114           IF (M .LT. 0) GO TO 23                                             ACH02300
00116           L = 0.28*ABS(DELU(KK))/UBAR(KK)*X                                  ACH02400
00117           IF (DELU(KK) .LT. 0.0) L = 0.0                                     ACH02500
00121           GO TO 25                                                           ACH02600
00122        23 L = 0.28*ABS(DELU(JF))/UBAR(JF)*X                                  ACH02700
00123           IF (DELU(JF) .LT. 0.0) L = 0.0                                     ACH02800
00125           GO TO 25                                                           ACH02900
00126        24 L = 0.28*ABS(DELU(M))/UBAR(M)*X                                    ACH03000
00127           IF (DELU(M) .LT. 0.0) L = 0.0                                      ACH03100
00131        25 CONTINUE                                                           ACH03200
00132           RETURN                                                             ACH03300
00133           ENTRY LATER(Y)                                                     ACH03400
00135           LAT = EXP(-0.5*(Y/SIGY)**2)                                        ACH03500
00136        40 RETURN                                                             ACH03600
00137           END                                                                ACH03700

END OF COMPILATION:        NO  DIAGNOSTICS.
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NASA/MSFC MULTILAYER DIFFUSION MODEL, VERSION 2  H E CRAMER CO                                   DATE 031473        PAGE   67

GFOR,US WASHT
FOR 010L-03/14/73-21:37:51 (0,1)

   SUBROUTINE WASHT      ENTRY POINT 000310

   STORAGE USED: CODE(1) 000351; DATA(0) 000050; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003   PARAMT 002173
    0004   PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005   COORD
    0006   NWDU$
    0007   NIO2$
    0010   EXP
    0011   NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001     000061 10L      0001     000075 15L      0001     000111 20L      0001     000137 35L      0001     000027 5L
    0001     000156 50L      0001     000161 60L      0001     000200 64L      0001     000221 65L      0001     000037 9L
    0000     000011 920F     0000 R 000001 A         0003     001725 ACCUR    0003     001056 ALPHA    0003     001777 ALPHL
    0004     001510 ALPHNK   0004 R 001034 ANG      0000 R 000007 ASP      0000 R 000002 B        0003     001114 BETA
    0004     001344 BETANK   0003     002011 BETL     0000 R 000003 C        0003     001605 CI       0004     000264 CON
    0000 R 000004 D          0003     000014 DATE     0003     001423 DECAY    0003     002172 DELPHI   0004     000074 DELTHP
    0004     000226 DELU     0003     000567 DELX     0003     000613 DELY     0004     000666 DEP      0004     001656 DEPN
    0003     001573 DI       0003     000423 DXR      0000 R 000005 E        0000 R 000006 G        0003     001203 H
    0003     001776 HB       0004 I 000441 I        0004 I 000454 IBOT     0003     001427 IFLAG    0004     000665 II
    0004 I 000450 ILK       0000     000136 INJP$    0003 I 000016 ISKIP   0000 I 000000 IS46    0004     000502 ITAG
    0004 I 000453 ITOP      0003 I 001377 IZMOD    0004 I 000442 J        0003     001631 JBOT     0004 I 000646 JF
    0003     001643 JTOP     0004 I 000443 KK       0004 R 000437 L        0003 R 001426 LAMBDA   0004     025276 LAT
    0004     000652 LB1      0004     000657 LB2      0004 R 000651 NPWR     0003 I 000062 NBK      0003     000060 NCI
    0003     000057 NDI      0003     000061 NDXR     0004     000452 NNZ      0003     000063 NPTS     0003     000065 NVB
    0003     000064 NVS      0004     001655 NXCI     0003     000054 NXS      0003     000055 NYS      0003     000056 NZS
    0004     000432 PEAKD    0003     001701 PERC     0003     001752 PERCB    0004     000547 PPWR     0003 R 000637 Q
    0004     000650 QPWR     0004     000451 RAD      0003     000710 SIGAK    0003     002052 SIGAL    0004     025444 SIGANK
    0004     000036 SIGAP    0003     000735 SIGEK    0003     002076 SIGEL    0004     025300 SIGENK   0004     000132 SIGEP
    0004     000435 SIGX     0004     000301 SIGXNK   0003     000762 SIGXO    0004 R 000434 SIGY     0004 R 025277 SIGYNK
    0003     001006 SIGYO    0004     000433 SIGZ     0003     001032 SIGZO    0004     001654 SQBAR    0004 R 000436 SQR2P
    0004     000444 STO1     0004     000445 STO2     0004     000446 STO3     0003     002146 T        0003 R 001617 TAST
    0003     001201 TAUK     0003     002023 TAUL     0003     001202 TAUOK    0003     002024 TAUOL    0003 I 000000 TESTNO
    0004     000440 TH       0004     000170 THETA    0003     001154 THETAK   0003     002122 THETAL   0003     001153 TIMAV
    0003 R 001425 TIM1      0004     000447 TRD      0004 R 000000 UBAR     0003     000663 UBARK    0003     002026 UBARL
    0004     001200 UBARNK   0003     001726 VB       0004     000430 VER      0004     000431 VREF     0003     001655 VS
    0004 R 001656 WASHOU    0004 R 000455 XAST     0004     001033 XBARX    0003     001231 XLRY     0003     001232 XLRZ
    0003     001227 XRY      0003     001230 XRZ      0000 R 000010 XS       0003 R 000066 XX       0004     000667 YBARY
    0003 R 000232 YY        0003 R 000376 Z        0003     001424 ZLIM     0003     001152 ZRK      0003     002025 ZRL
    0003     001233 ZZL
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      SUBROUTINE WASHT(X,Y,ISW5,XO,YO,N,K)                              WSH00100
      COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI, WSH00200
     1NDXR,NBK,NPTS,NVS,NVR,XX(100),YY(100),Z(21),DXR(100),DELX(20),    WSH00300
     2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20), WSH00400
     3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)WSH00500
     4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,     WSH00600
     5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),       WSH00700
     6PERC(20),ACCUR,VR(20),PERCD(20),HS,ALPHL(10),BETL(10),TAUL,TAUOL, WSH00800
     7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI         WSH00900
      COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),WSH01000
     1DELU(30),CON(100),VER,VREF,FLAKD,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,WSH01100
     2ST01,ST02,ST03,TRO,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)WSH01200
     3,JF,PPWR,QPWR,MPWR,LB1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),WSH01300
     4UBARNK(100),BETANK(100),ALPHNK(100),SBAR,NXCI,DEPN(100,100),LAT,  WSH01400
     5SIGYNK,SIGENK(100),SIGANK(100)                                    WSH01500
      DIMENSION WASHOU(100,100)                                         WSH01700
      EQUIVALENCE (DEPN,WASHOU)                                         WSH01800
      REAL MPWR,L,LAMBDA                                                WSH01900
      INTEGER TESTNO                                                    WSH02000
C     THIS SUBROUTINE CALCULATES WASHOUT DEPOSITION FOR ALL MODELS .    WSH02100
      ISW6 = 0                                                          WSH02200
      IF (NBK .NE. 0.AND.IBOT.LE.KK.AND.KK.LE.ITOP) GO TO 60            WSH02300
      IF (N .EQ. 9) GO TO 50                                            WSH02400
    5 IF (TIM1 .LT. X/UBAR(KK)) GO TO 9                                 WSH02500
      GO TO 50                                                          WSH02600
    9 IF (TIM1 .LT. (X-2.15*ANG(6))/UBAR(KK)) GO TO 10                  WSH02700
      WRITE (6,920) XX(I),YY(J)                                         WSH02800
   10 A = UBAR(KK)                                                      WSH02900
      SIGY = ANG(5)                                                     WSH03000
      B = SIGY                                                          WSH03100
      C = 1.0                                                           WSH03200
      D = 1.0                                                           WSH03300
      E = 1.0                                                           WSH03400
      G = TIM1                                                          WSH03500
   15 CONTINUE                                                          WSH03600
      IF (B .LE. 0.0) GO TO 50                                          WSH03650
      IF (IZMOD(KK) .EQ. 3) GO TO 20                                    WSH03700
      D = Z(KK+1)-Z(KK)                                                 WSH03800
   20 E = EXP(-.5*(Y/B)**2)                                             WSH03900
      IF (ISKIP(7) .EQ. 1) GO TO 35                                     WSH04000
      C = EXP(-LAMBDA*(X/A-G))                                          WSH04100
   35 CONTINUE                                                          WSH04200
      WASHOU(I,J) = WASHOU(I,J)+(LAMBDA*Q(KK)/(SQR2P*A*B))*C*D*E        WSH04300
   50 CONTINUE                                                          WSH04400
      RETURN                                                            WSH04500
   60 IF (ISW5 .EQ. 0) GO TO 64                                         WSH04600
      N = 1                                                             WSH04700
      CALL COORD(N,KK,X,Y,XO,YO,ASP,XS,1)                               WSH04800
   64 IF (X .GT. XAST(KK).OR.N .EQ. 9) GO TO 66                         WSH04900
      SIGY = ANG(5)                                                     WSH05000
      GO TO 5                                                           WSH05100
   66 N = 1                                                             WSH05200
      CALL COORD(N,KK,X,Y,XO,YO,ASP,XS,2)                               WSH05300
   70 IF (N .EQ. 9) GO TO 50                                            WSH05400
      IF (X/UBAR(JF)+TAST(ILK-1) .LE. TIM1) GO TO 50                    WSH05500
      ISW6 = 1                                                          WSH05600
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00173     57*           SIGYNK = ANG(4)                                              WSH05700
00174     58*           A = UBAR(JF)                                                 WSH05800
00175     59*           B = SIGYNK                                                   WSH05900
00176     60*           C = 1.0                                                      WSH06000
00177     61*           D = 1.0                                                      WSH06100
00200     62*           E = 1.0                                                      WSH06200
00201     63*           IF (ISKIP(7) .EQ. 1) GO TO 15                                WSH06300
00203     64*           G = TIM1-TAST(ILK-1)                                         WSH06400
00204     65*           GO TO 15                                                     WSH06500
00205     66*       920 FORMAT (1H0,29H *** WASHOUT DEPOSITION AT X=,F10.3,4H, Y=,F10.3,26WSH06600
00205     67*          1H MAY BE OVER ESTIMATED ***)                                 WSH06700
00206     68*           END                                                          WSH06800

    END OF COMPILATION:        NO  DIAGNOSTICS.
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QFOR,US ISO
FOR 010L-03/14/73-21:37:54 (0,1)

   SUBROUTINE ISO       ENTRY POINT 000122

   STORAGE USED: CODE(1) 000131; DATA(0) 000062; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003   PARAMT 002173
    0004   PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005   NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001     000021 121G      0003     001725 ACCUR     0003     001056 ALPHA     0003     001777 ALPHL     0004     001510 ALPHNK
    0004     001034 ANG       0000 D   000010 A10       0000 D   000012 A11       0000 D   000000 A6        0000 D   000002 A7
    0000 D   000004 A8        0000 D   000006 A9        0003     001114 BETA      0004     001344 BETANK    0003     002011 BETL
    0003     001605 CI        0004     000264 CON       0003     000014 DATE      0003     001423 DECAY     0003     002172 DELPHI
    0004     000074 DELTHP    0004     000226 DELU      0003     000567 DELX      0003     000613 DELY      0004     000666 DEP
    0004     001656 DEPN      0003     001573 DI        0000 D   000014 DTX       0003     000423 DXR       0004 R   001045 ERFX
    0003     001203 H         0003     001776 HB        0004     000441 I         0004     000454 IBOT      0003     001427 IFLAG
    0004     000065 II        0004     000450 ILK       0000 I   000017 IN        0000     000036 INJP$     0003     000016 ISKIP
    0004     000502 ITAG      0004     000453 ITOP      0003     001377 IZMOD     0004     000442 J         0003     001631 JBOT
    0004     000646 JF        0003     001643 JTOP      0004     000443 KK        0004 R   000437 L         0003 R   001426 LAMBDA
    0004     025276 LAT       0004     000652 LB1       0004     000657 LB2       0000 I   000016 M         0004 R   000651 MPWR
    0003     000062 NBK       0003     000060 NCI       0003     000057 NDI       0003     000061 NDXR      0004     000452 NNZ
    0003     000063 NPTS      0003     000065 NVB       0003     000064 NVS       0004     001655 NXCI      0003     000054 NXS
    0003     000055 NYS       0003     000056 NZS       0004     000432 PEAKD     0003     001701 PERC      0003     001752 PERCB
    0004     000047 PPWR      0003     000637 Q         0004     000650 QPWR      0004     000451 RAD       0003     000710 SIGAK
    0003     002052 SIGAL     0004     025444 SIGANK    0004     000036 SIGAP     0003     000735 SIGEK     0003     002076 SIGEL
    0004     025300 SIGENK    0004     000132 SIGEP     0004     000435 SIGX      0004     000501 SIGXNK    0003     000762 SIGXO
    0004     000434 SIGY      0004     025277 SIGYNK    0003     001006 SIGYO     0004     000433 SIGZ      0003     001032 SIGZO
    0004     001654 SUBAR     0004     000436 SQR2P     0004     000444 STO1      0004     000445 STO2      0004     000446 STO3
    0003     002146 T         0003     001617 TAST      0003     001201 TAUK      0003     002023 TAUL      0003     001202 TAUOK
    0003     002024 TAUOL     0003 I   000000 TESTNO    0004     000440 TH        0004     000170 THETA     0003     001154 THETAK
    0003     002122 THETAL    0003     001153 TIMAV     0003     001425 TIM1      0004     000447 TRD       0004     000000 UBAR
    0003     000663 UBARK     0003     002026 UBARL     0004     001200 UBARNK    0003     001726 VB        0004     000430 VER
    0004     000431 VREF      0003     001655 VS        0004     000455 XAST      0004     001033 XBARX     0003     001231 XLRY
    0003     001232 XLRZ      0003     001227 XRY       0003     001230 XRZ       0003     000066 XX        0004     000667 YBARY
    0003     000232 YY        0003     000376 Z         0003     001424 ZLIM      0003     001152 ZRK       0003     002025 ZRL
    0003     001233 ZZL


00101      1*         SUBROUTINE ISO(NR,MT)                                              ISO00100
00103      2*         COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI,  ISO00200
00103      3*        1NDXR,NBK,NPTS,NVS,NVB,XX(100),YY(100),Z(21),DXR(100),DELX(20),     ISO00300
00103      4*        2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20),  ISO00400
```

```
00103          3SIGZO(20),ALPHA(30),BETA(30),ZPK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)IS000500
00103          4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIMI,LAMBDA,      IS000600
00103          5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),        IS000700
00103          6PERC(20),ACCUR,VR(20),PERCB(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL,  IS000800
00103          7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI          IS000900
00104           COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),IS001000
00104          1DELU(30),COM(100),VER,VREF,PEAKD,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,IS001100
00104          2STO1,STO2,STO3,TRD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)IS001200
00104          3,JF,PPWR,OPWR,MPWR,LP1(5),LP2(6),II,DEP,YBARY(100),XBAPX,ANG(100),IS001300
00104          4UBARNK(100),BETANK(100),ALPHNK(100),SGBAR,NXCI,DEPN(100,100),LAT,  IS001400
00104          5SIGYNK,SIGLNK(100),SIGANK(100)                                     IS001500
00105           DIMENSION ERFX(6)                                                  IS001600
00106           EQUIVALENCE (ANG(10),ERFX)                                         IS001700
00107           INTEGER TESTNO                                                     IS001800
00110           REAL MPWR,L,LAMBDA                                                 IS001900
00111           DOUBLE PRECISION A6,A7,A8,A9,A10,A11,DTX                           IS002000
00111     C     THIS SUBROUTINE EVALUATES ERF(X)                                   IS002100
00112           A6 = .0705230784D0                                                 IS002200
00113           A7 = .0422820123D0                                                 IS002300
00114           A8 = .0092705272D0                                                 IS002400
00115           A9 = .0001520143D0                                                 IS002500
00116           A10 = .0002765672D0                                                IS002600
00117           A11 = .0000430638D0                                                IS002700
00120           DO 10 M=MR,MT                                                      IS002800
00123           IN = 0                                                             IS002900
00124           IF (ERFX(M) .LT. 0.0) IN = 1                                       IS003000
00126           ERFX(M) = ABS(ERFX(M))                                             IS003100
00127           DTX = 1.0D0+A6*ERFX(M)+A7*ERFX(M)**2+A8*ERFX(M)**3+A9*ERFX(M)**4+  IS003200
00127          1A10*ERFX(M)**5+A11*ERFX(M)**6                                      IS003300
00130           ERFX(M) = 1.0D0-(1.0D0/DTX**16)                                    IS003400
00131           IF (IN .EQ. 1) ERFX(M) = -ERFX(M)                                  IS003500
00133        10 CONTINUE                                                           IS003600
00135           RETURN                                                             IS003700
00136           END                                                                IS003800
```

END OF COMPILATION: NO DIAGNOSTICS.

```
@FOR,US PEAK
FOR 016L-03/14/73-21:37:55 (0,1)

   SUBROUTINE PEAK       ENTRY POINT 000054

   STORAGE USED: CODE(1) 000061; DATA(0) 000011; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003   PARAMT 002173
    0004   PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005   NERR2$
    0006   NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001   000014 10L       0001   000023 20L       0001   000032 25L       0001   000042 30L       0001   000044 40L
    0003   001725 ACCUR     0003   001056 ALPHA     0003   001777 ALPHL     0004   001510 ALPHNK    0004   001034 ANG
    0003   001114 BETA      0004   001344 BETANK    0003   002011 BETL      0003   001605 CI        0004   000264 CON
    0003   000014 DATE      0003   001423 DECAY     0003   002172 DELPHI    0004   000074 DELTHP    0004   000226 DELU
    0003   000567 DELX      0003   000613 DELY      0004   000666 DEP       0004   001656 DEPN      0003   001573 DI
    0003   000423 DXR       0003   001203 H         0003   001776 HB        0004   000441 I         0004   000454 IBOT
    0003   001427 IFLAG     0004   000665 II        0004   000450 ILK       0000   000002 INJP$     0003   000016 ISKIP
    0004   000502 ITAG      0004   000453 ITOP      0003 I 001377 IZMOD     0004   000442 J         0003   001631 JBOT
    0004   000646 JF        0003   001643 JTOP      0004 I 000443 KK        0004 R 000437 L         0003 R 001426 LAMBDA
    0004   025276 LAT       0004   000652 LB1       0004   000657 LB2       0000 I 000000 M         0004 R 000651 MPWR
    0003   000062 NBK       0003   000060 NCI       0003   000057 NDI       0003   000061 NDXR      0004   000452 NNZ
    0003   000063 NPTS      0003   000065 NVR       0003   000064 NVS       0004   001655 NXCI      0003   000054 NXS
    0003   000055 NYS       0003   000056 NZS       0004 R 000432 PEAKD     0003   001701 PERC      0003   001752 PERCB
    0004   000047 PPWR      0003 R 000637 Q         0004   000650 QPWR      0004   000451 RAD       0003   000710 SIGAK
    0003   002052 SIGAL     0004   025444 SIGANK    0004   000036 SIGAP     0003   000735 SIGEK     0003   002076 SIGEL
    0004   025300 SIGENK    0004   005132 SIGEP     0004   000435 SIGX      0004   000501 SIGXNK    0003   000762 SIGXO
    0004 R 000434 SIGY      0004   025277 SIGYNK    0003   001006 SIGYO     0004 R 000433 SIGZ      0003   001032 SIGZO
    0004   001654 SUBAR     0004 R 000436 SQR2P     0004 R 000444 STO1      0004   000445 STO2      0004   000446 STO3
    0003   002146 T         0003   001617 TAST      0003   001201 TAUK      0003   002023 TAUL      0003   001202 TAUOK
    0003   002024 TAUOL     0003 I 000000 TESTNO    0004   000440 TH        0004   000170 THETA     0003   001154 THETAK
    0003   002122 THETAL    0003   001153 TINAV     0003   001425 TIM1      0004   000447 TRD       0004 R 000000 UBAR
    0003   000663 UBARK     0003   002026 UBARL     0004   001260 UBARNK    0003   001726 VB        0004   000430 VER
    0004   000431 VREF      0003   001655 VS        0004   000455 XAST      0004   001033 XBARX     0003   001231 XLRY
    0003   001232 XLRZ      0003   001227 XRY       0003   001230 XRZ       0003   000066 XX        0004   000667 YBARY
    0003   000232 YY        0003   000376 Z         0003   001424 ZLIM      0003   001152 ZRK       0003   002025 ZRL
    0003   001233 ZZL


00101      1*          SUBROUTINE PEAK(NN,K)                                                PEK00100
00103      2*          COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI,    PEK00200
00103      3*         1NDXR,NBK,NPTS,NVS,NVR,XX(100),YY(100),Z(21),DXR(100),DELX(20),       PEK00300
00103      4*         2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20),    PEK00400
```

```
00103           3SIGZ0(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)PEK00500
00103           4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,      PEK00600
00103           5IFLAG(100),DI(10),CI(10),TASI(10),JBOT(10),JTOP(10),VS(20),        PEK00700
00103           6PERC(20),ACCUR,VB(20),PERCB(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL,  PEK00800
00103           7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI          PEK00900
00104            COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),PEK01000
00104           1DELU(30),CON(100),VCP,VREF,PEAKD,SIGZ,SIGY,SIGX,SQR2P,L,TH,I,J,KK,PEK01100
00104           2ST01,ST02,ST03,TRD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAS(100)PEK01200
00104           3,JF,PPWR,OPWR,MPWR,LB1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),PEK01300
00104           4UBARNK(100),BETANK(100),ALPHNK(100),SQBAR,NXCI,DEPN(100,100),LAT,  PEK01400
00104           5SIGYNK,SIGLNK(100),SIGANK(100)                                      PEK01500
00105            INTEGER TESTNO                                                      PEK01600
00106            REAL MPWR,L,LAMBDA                                                  PEK01700
00106     C       ***** THIS SUBROUTINE CALCULATES THE PEAK TERM *****               PEK01800
00107            M = IZMOD(KK)                                                       PEK01900
00110            GO TO (10,10,20),M                                                  PEK02000
00111         10 ST01 = Q(KK)/(SQR2P*SIGY*UBAR(KK))                                  PEK02100
00112            GO TO 25                                                            PEK02200
00113         20 ST01 = Q(KK)/(6.2831853*SIGY*SIGZ*UBAR(KK))                         PEK02300
00114         25 GO TO (30,40),NN                                                    PEK02400
00115         30 PEAKD = ST01                                                        PEK02500
00116         40 RETURN                                                              PEK02600
00117            END                                                                 PEK02700
```

END OF COMPILATION: NO DIAGNOSTICS.

```
@FOR,US TESTR
FOR 010L-05/30/73-13:16:16 (1,2)

   SUBROUTINE TESTR      ENTRY POINT 000056

   STORAGE USED: CODE(1) 000066; DATA(0) 000011; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003    PARAMT 002173
    0004    PARAMS 025610

   EXTERNAL REFERENCES (BLOCK, NAME)

    0005    NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001     000044 100L      0001     000034 1256      0001     000017 50L       0001     000043 61L       0003     001725 ACCUR
    0003     001056 ALPHA     0003     001777 ALPHL     0004     001510 ALPHNK    0004     001034 ANG       0003     001114 BETA
    0004     001344 BETANK    0003     002011 BETL      0003     001605 CI        0004     000264 CON       0003     000014 DATE
    0003     001423 DECAY     0003     002172 DELPHI    0004     000074 DELTHP    0004     000226 DELU      0003     000567 DELX
    0003     000613 DELY      0004     000666 DEP       0004     001656 DEPN      0003     001573 DI        0003     000423 DXR
    0003     001203 H         0003     001776 HB        0004     000441 I         0004 I   000454 IBOT      0003     001427 IFLAG
    0004     000665 II        0004 I   000450 ILK       0000     000001 INJP$     0003     000016 ISKIP     0004     000502 ITAG
    0004 I   000453 ITOP      0003     001377 IZMOD     0004 I   000442 J         0003 I   001631 JBOT      0004     000646 JF
    0003 I   001643 JTOP      0004 I   000443 KK        0004 R   000437 L         0003 R   001426 LAMBDA    0004     025276 LAT
    0004     000652 LB1       0004     000657 LB2       0004 R   000651 MPWR      0003 I   000062 NBK       0003     000060 NCI
    0003     000057 NDI       0003     000061 NDXR      0004     000452 NNZ       0003     000063 NPTS      0003     000065 NVB
    0003     000064 NVS       0004     001655 NXCI      0003     000054 NXS       0003     000055 NYS       0003     000056 NZS
    0004     000432 PEAKD     0003     001701 PERC      0003     001752 PERCB     0004     000647 PPWR      0003     000637 Q
    0004     000650 QPWR      0004     000451 RAD       0003     000710 SIGAK     0003     002052 SIGAL     0004     025444 SIGANK
    0004     000036 SIGAP     0003     000735 SIGEK     0003     002076 SIGEL     0004     025300 SIGENK    0004     000132 SIGEP
    0004     000435 SIGX      0004     000501 SIGXNK    0003     000762 SIGXO     0004     000434 SIGY      0004     025277 SIGYNK
    0003     001006 SIGYO     0004     000433 SIGZ      0003     001032 SIGZO     0004     001654 SQBAR     0004     000436 SQR2P
    0004     000444 STO1      0004     000445 STO2      0004     000446 STO3      0003     002146 T         0003 R   001617 TAST
    0003     001201 TAUK      0003     002023 TAUL      0003     001202 TAUOK     0003     002024 TAUOL     0003 I   000000 TESTNO
    0004     000440 TH        0004     000170 THETA     0003     001154 THETAK    0003     002122 THETAL    0003     001153 TIMAV
    0003     001425 TIM1      0004     000447 TRD       0004 R   000000 UBAR      0003     000663 UBARK     0003     002026 UBARL
    0004     001200 UBARNK    0003     001726 VB        0004     000430 VER       0004     000431 VREF      0003     001655 VS
    0004 R   000455 XAST      0004     001033 XBARX     0003     001231 XLRY      0003     001232 XLRZ      0003     001227 XRY
    0003     001230 XRZ       0003     000066 XX        0004     000667 YBARY     0003     000232 YY        0003     000376 Z
    0003     001424 ZLIM      0003     001152 ZRK       0003     002025 ZRL       0003     001233 ZZL


00101       1*           SUBROUTINE TESTR(KTK)                                          TST00100
00103       2*          COMMON /PARAMT/ TESTNO(12),DATE(2),ISKIP(30),NXS,NYS,NZS,NDI,NCI,  TST00200
00103       3*         1NDXR,NBK,NPTS,NVS,NVB,XX(100),YY(100),Z(21),DXR(100),DELX(20),   TST00300
00103       4*         2DELY(20),Q(20),UBARK(21),SIGAK(21),SIGEK(21),SIGXO(20),SIGYO(20), TST00400
00103       5*         3SIGZO(20),ALPHA(30),BETA(30),ZRK,TIMAV,THETAK(21),TAUK,TAUOK,H(20)TST00500
00103       6*         4,XRY,XRZ,XLRY,XLRZ,ZZL(100),IZMOD(20),DECAY,ZLIM,TIM1,LAMBDA,      TST00600
```

```
00103          5IFLAG(100),DI(10),CI(10),TAST(10),JBOT(10),JTOP(10),VS(20),          TST00700
00103          6PERC(20),ACCUR,VB(20),PERCB(20),HB,ALPHL(10),BETL(10),TAUL,TAUOL,    TST00800
00103          7ZRL,UBARL(20),SIGAL(20),SIGEL(20),THETAL(20),T(20),DELPHI           TST00900
00104           COMMON /PARAMS/ UBAR(30),SIGAP(30),DELTHP(30),SIGEP(30),THETA(30),TST01000
00104          1DELU(30),CON(100),VER,VREF,PEAKD,SIGZ,SIGY,SIGX,SUR2P,L,TH,I,J,KK,TST01100
00104          2STO1,STO2,STO3,TPD,ILK,RAD,NNZ,ITOP,IBOT,XAST(20),SIGXNK,ITAG(100)TST01200
00104          3,JF,PPAR,QPAR,MPWR,LB1(5),LB2(6),II,DEP,YBARY(100),XBARX,ANG(100),TST01300
00104          4UBARNK(100),BETANK(100),ALPHNK(100),SOBAR,NXCI,DEPN(100,100),LAT,  TST01400
00104          5SIGYNK,SIGENK(100),SIGANK(100)                                     TST01500
00105           INTEGER TESTNO                                                     TST01600
00106           REAL NPAR,L,LAMBDA                                                 TST01700
00106     C     THIS SUBROUTINE DETERMINES THE STRUCTURAL CHANGE IN LAYERS FOR     TST01800
00106     C     THE PULL TRANSITION MODEL                                          TST01900
00107           IF (KSK .EQ. 0) GO TO 100                                          TST02000
00111           IF (KK .NE. JBOT(ILK)) GO TO 61                                    TST02100
00113           IBOT = KK                                                          TST02200
00114           ITOP = JTOP(ILK)                                                   TST02300
00115           DO 60 J=IBOT,ITOP                                                  TST02400
00120        60 XAST(J) = UBAR(J)*TAST(ILK)                                        TST02500
00122           ILK = ILK+1                                                        TST02600
00123        61 CONTINUE                                                           TST02700
00124           KTK = 0                                                            TST02800
00125       100 CONTINUE                                                           TST02900
00126           RETURN                                                             TST03000
00127           END                                                                TST03100
```

END OF COMPILATION: NO DIAGNOSTICS.

```
QMAP,I
MAP 0017-05/30-13:16


ADDRESS LIMITS     001000 031670      040000 100502
STARTING ADDRESS   015334
WORDS DECIMAL       12729 IBANK        16707 DBANK


            SEGMENT MAIN           001000 031670      040000 100502

NSWTCS/FOR                 1   001000 001021
NRBLKS/FOR64               1   001022 001044
NRWNDS/FOR64               1   001045 001124      2   040000 040011
NWEFS/FOR64                1   001125 001326      2   040012 040031
NFTCHS/FOR64               1   001327 001616      2   040032 040067
NINPTS/FOR64               1   001617 002477      2   040070 040113
NFTVS/FOR                  1   002500 002522
NCLOSS/FOR64               1   002523 002676      2   040114 040144
NWBLKS/FOR64               1   002677 003020
NBSBLS/FOR64               1   003021 003055
NUPDAS/FOR64               1   003056 003110
NBF00S/FOR                                        2   040145 042346
NBDCVS/FOR64               1   003111 003236      2   042347 042411
NCNVTS/FOR64               1   003237 003456      2   042412 042506
NININS/FOR66               1   003457 003654      2   042507 042522
NIRECS/UUCC67                                     0   042523 042576
NOTINS/FOR64               1   003655 004151      2   042577 042602
NOUTS/FOR64                1   004152 005154      2   042603 042631
NFMTS/FOR64                1   005155 006024      2   042632 042706
NIOERS/FOR64               1   006025 006160      2   042707 043012
NFCHKS/FOR64               1   006161 007040      2   043013 043150
                                                  4   043151 043222
NTABS/UUCC                                        2   043223 043322
ERUS/67-02
NLOUTS/FOR63               1   007041 010123      2   043323 043360
ALOGS/FOR59                1   010124 010243      2   043361 043421
NLINPS/FOR64               1   010244 011757      2   043422 043605
ATANS/FOR59                1   011760 012163      2   043606 043637
ASINCOSS/FOR59             1   012164 012400      0   043640 043665
SINCOSS/FOR59              1   012401 012533      2   043666 043707
SQRTS/FOR59                1   012534 012574      2   043710 043721
NEXP6S/FOR62               1   012575 012771      2   043722 043773
HSMONITOR/RALPH            1   012772 014031      2   043774 044516
EXPS/FOR59                 1   014032 014121      2   044517 044537
NIERS/FOR64                1   014122 014221      2   044540 044601
NOBUFS/FOR64               1   014222 014266
NERRS/FOR64                1   014267 014652      2   044602 044760
PARAMS (COMMON BLOCK)                                 044761 072570
```

```
PARAMT (COMMON BLOCK)                                      072571 074763
BLANKSCOMMON (COMMON BLOCK)
TESTR                       1   014653 014722        0     074764 074774
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
PEAK                        1   014723 015003        0     074775 075005
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
ISO                         1   015004 015134        0     075006 075067
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
WASHT                       1   015135 015505        0     075070 075137
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
ACH                         1   015506 015642        0     075140 075152
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
VERT                        1   015643 016060        0     075153 075177
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
SIGMA                       1   016061 016552        0     075200 075233
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
COORD                       1   016553 020367        0     075234 075313
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
SGP                         1   020370 021710        0     075314 075373
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
READER                      1   021711 024140        0     075374 076055
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
ISOYZ                       1   024141 024714        0     076056 076302
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
ISOXY                       1   024715 025576        0     076303 076542
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
CENTRL                      1   025577 026171        0     076543 076736
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
DEPOS                       1   026172 027273        0     076737 077367
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
BREAK                       1   027274 030424        0     077370 077452
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS
MODEL                       1   030425 031647        0     077453 100502
                            3   PARAMT               2     BLANK$COMMON
                                                     4     PARAMS

SYS$*RLIB$. LEVEL 67-02
END OF COLLECTION - TIME 2.401 SECONDS
```

APPENDIX D

NASA/MSFC MULTILAYER COMPUTER PROGRAM EXAMPLE OUTPUT

The three example output listings given in this appendix show only a small part of the program capabilities, but give the basic form of all program output. Certain pages in the output listings have been omitted due to volume, but important material is retained.

D.1 EXAMPLE 1 OUTPUT LISTING

Example 1 gives the output from a problem where maximum centerline concentration and centerline dosage are calculated using a sea-breeze meteorological regime under normal launch conditions. The listing was produced by logic section 1 of the computer program using Model 4. A full explanation of this case is given in Section 6.2.1 of the main body of the report. Also, an example coding sheet of inputs for this case is given in Figure B-3 of Appendix B.

The case title is printed at the top of the listing followed by a complete list of all program inputs for detailed input verification. The program then produces a summary of the layer parameters including those applicable to the new layer structure used in Model 4. Accompanying the input summary are specific layer parameters used in the calculations. The main dosage and concentration listing is then printed, giving the locations and values at each calculation point within the layer. Logic section 1 is normally used for general grid pattern calculations, but in this case, the special option NYS=1 was selected which automatically places all calculations on the alongwind cloud axis.

```
 *-*-* TITLE=CONCENTRATION, NORMAL LAUNCH, SEA BREEZE CASE 1, H=832M,          ; DATE=MARCH 11 73  *-*-*
$NAM2
ISSNO  =      +8930493075,    +27231097748,    +21174236439,    +19432494150,
             +28238207677,    +25939169751,    +10913358152,     +6847749230,
              +5526482802,    +20100436293,     +5453926725,     +5453926725
ISKIP  =               +0,              +1,              +0,              +0,
                       +0,              +0,              +0,              +0,
                       +0,              +0,              +0,              +0,
                       +0,              +0,              +0,              +0,
                       +0,              +0,              +0,              +0,
                       +0,              +0,              +0,              +0,
                       +0,              +0,              +0,              +0,
                       +0,              +0
NXS    =              +34
NYS    =               +1
NZS    =              +12
NDI    =               +0
NC1    =               +0
NDAR   =              +34
NDA    =               +1
NPTS   =               +4
NVS    =               +0
NV6    =               +0
XX     =    .50000000E+03,   .60000000E+03,   .70000000E+03,   .80000000E+03,
            .90000000E+03,   .10000000E+04,   .12500000E+04,   .15000000E+04,
            .17500000E+04,   .20000000E+04,   .25000000E+04,   .30000000E+04,
            .35000000E+04,   .40000000E+04,   .50000000E+04,   .60000000E+04,
            .70000000E+04,   .80000000E+04,   .90000000E+04,   .10000000E+05,
            .12500000E+05,   .15000000E+05,   .17500000E+05,   .20000000E+05,
            .25000000E+05,   .30000000E+05,   .35000000E+05,   .40000000E+05,
            .50000000E+05,   .60000000E+05,   .70000000E+05,   .80000000E+05,
            .90000000E+05,   .10000000E+06,   .00000000E+00,   .00000000E+00,
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YY     =    .16000000E+03,   .16500000E+03,   .17000000E+03,   .17500000E+03,
            .18000000E+03,   .18500000E+03,   .19000000E+03,   .19500000E+03,
            .20000000E+03,   .20500000E+03,   .21000000E+03,   .21500000E+03,
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            .30000000E+03,   .30500000E+03,   .31000000E+03,   .31500000E+03,
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DXR	=	.50000000E+03,	.60000000E+03,	.70000000E+03,	.80000000E+03,
		.90000000E+03,	.10000000E+04,	.12500000E+04,	.15000000E+04,
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		.35000000E+04,	.40000000E+04,	.50000000E+04,	.60000000E+04,
		.70000000E+04,	.80000000E+04,	.90000000E+04,	.10000000E+05,
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		.50000000E+05,	.60000000E+05,	.70000000E+05,	.80000000E+05,
		.90000000E+05,	.10000000E+06,	.00000000E+00,	.00000000E+00,
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DELX	=	.00000000E+00,	.00000000E+00,	.00000000E+00,	.00000000E+00,
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DELY	=	.00000000E+00,	.00000000E+00,	.00000000E+00,	.00000000E+00,
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		.00000000E+00,	.00000000E+00,	.00000000E+00,	.00000000E+00,

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Q          =     .14400000E+06,  .34900000E+06,  .96600000E+06,  .22700000E+07,
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                 .96100000E+07,  .54000000E+06,  .16700000E+04,  .00000000E+00,
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UBARK      =     .60000000E+01,  .89000000E+01,  .96000000E+01,  .99000000E+01,
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SIGAK      =     .60000000E+01,  .54100000E+01,  .50500000E+01,  .48500000E+01,
                 .47100000E+01,  .46100000E+01,  .45200000E+01,  .44500000E+01,
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SIGEK      =     .75900000E+01,  .51300000E+01,  .47900000E+01,  .46000000E+01,
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SIGXO      =     .14880000E+02,  .44650000E+02,  .74420000E+02,  .10419000E+03,
                 .13395000E+03,  .16372000E+03,  .19349000E+03,  .22326000E+03,
                 .18277000E+03,  .93000000E+02,  .93000000E+02,  .00000000E+00,
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SIGYO      =     .14880000E+02,  .44650000E+02,  .74420000E+02,  .10419000E+03,
                 .13395000E+03,  .16372000E+03,  .19349000E+03,  .22326000E+03,
                 .18277000E+03,  .93000000E+02,  .93000000E+02,  .00000000E+00,
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SIGZO      =     .28870000E+02,  .28870000E+02,  .28870000E+02,  .28870000E+02,
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ALPHA      =     .10000000E+01,  .10000000E+01,  .10000000E+01,  .10000000E+01,
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BETA       =     .10000000E+01,  .10000000E+01,  .10000000E+01,  .10000000E+01,
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ZRK        =     .20000000E+01
TIMAV      =     .60000000E+03
```

```
THETAK =  .15000000E+03,  .15000000E+03,  .15000000E+03,  .15200000E+03,
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TAUK   =  .56100000E+03
TAUOK  =  .60000000E+03
H      =  .75100000E+03,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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XRY    =  .10000000E+03
XRZ    =  .10000000E+03
XLRY   =  .00000000E+00
XLRZ   =  .00000000E+00
ZZL    =  .20000000E+01,  .80000000E+03,  .13600000E+04,  .18000000E+04,
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          .00000000E+00,  .00000000E+00,  .20000000E+00,  .00000000E+00
IZMOD  =             +1,             +1,             +1,             +1,
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                     +1,             +1,             +1,             +0,
                     +0,             +0,             +0,             +0,
                     +0,             +0,             +0,             +0
DECAY  =  .00000000E+00
ZLIM   =  .00000000E+00
TIM1   =  .00000000E+00
BLAMDA =  .99999999E+00
DXR    =  .50000000E+03,  .60000000E+03,  .70000000E+03,  .80000000E+03,
          .90000000E+03,  .10000000E+04,  .12500000E+04,  .15000000E+04,
          .17500000E+04,  .20000000E+04,  .25000000E+04,  .30000000E+04,
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          .70000000E+04,  .80000000E+04,  .90000000E+04,  .10000000E+05,
          .12500000E+05,  .15000000E+05,  .17500000E+05,  .20000000E+05,
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IFLAG     =               +0,             +0,             +0,             +0,
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                          +0,             +0,             +0,             +0,
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                          +0,             +0,             +0,             +0,
                          +0,             +0,             +0,             +0,
                          +0,             +0,             +0,             +0,
                          +0,             +0,             +0,             +0
UI        =    .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00
CI        =    .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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               .00000000E+00,  .00000000E+00
IAST      =    .10000000E+01,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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               .00000000E+00,  .00000000E+00
JSOT      =               +1,             +0,             +0,             +0,
                          +0,             +0,             +0,             +0,
                          +0,             +0
JTOP      =               +0,             +0,             +0,             +0,
```

```
                          +0,             +0,             +0,             +0,
                          +0,             +0
VS        =   .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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              .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
PERC      =   .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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              .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
ACCUR     =   .00000000E+00
V3        =   .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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              .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
              .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
PERCB     =   .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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              .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
              .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
              .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
H3        =   .00000000E+00
$END

                              ***** LAYER 1 *****

                               ** INPUT DATA **

 Q=  .1440000D+06, ZRK=  2.000, UBAR AT BOTTOM=  6.0000, UBAR AT TOP=  8.9000, SIGAK AT BOTTOM= 8.00000
SIGAK AT TOP= 5.41000, SIGEK AT BOTTOM= 7.59000, SIGEK AT TOP= 5.15000, TAUK= 461.000, TAUOK= 600.000
SIGXO=  14.8800, SIGYO=  14.2800, SIGZO=  28.9700, THETAK AT BOTTOM=150.0000, THETAK AT TOP=150.0000, Z=    2.000
ALPHA=1.00 BETA=1.00, H=  751.000, DELX=  .00000000   , DELY=  .00000000   , DELPHI=180.0000, IZMOD=1, TIM1=  .00000000
ZLIM=      .000, LAMBDA=  .0000, TIMAV= 600.000, XRY= 100.000, XRZ= 100.000, XLRY=     .000, XLRZ=     .000

 ZRL=  2.000, UBARL AT BOTTOM=  6.0000, UBARL AT TOP= 10.9000, SIGAL AT BOTTOM= 8.00000, SIGAL AT TOP= 4.39000
SIGEL AT BOTTOM= 7.59000, SIGEL AT TOP= 4.17000, THETAL AT BOTTOM=150.0000, THETAL AT TOP=180.0000, TAUL= 461.000
TAUOL= 600.000, ALPHL=1.00, BETL=1.00, TAST=  .10000000+01, JBOT= 1, JTOP= 8

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =   8.13807, THETA = 150.00000, DELTHP =    .00000, DELU =   2.90000
, SIGAP =    .09855, SIGEP =    .09852

CALCULATED INPUT PARAMETERS FOR LAYER CHANGE MODELS *** UBAR =   9.92348, THETA = 165.00000, DELTHP =  30.00000
  DELU =   4.90000, SIGAP =    .08061, SIGEP =    .08079
          ------------------------------------------------------------------------------------------------
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                         *-* DOSAGE AND CONCENTRATION PATTERNS *-*

   ** CALCULATION HEIGHT Z=    2.000, CLOUD AXIS IS AT 345.000 DEGREES AZIMUTH BEARING RELATIVE TO ORIGIN

                                     * X=    500.00 *
**** Y=    345.00, DOSAGE=  .71812986+02, CONCENTRATION=  .12887471+02, TIME AVERAGE CONCENTRATION=  .11968831+00
                   TIME OF PASSAGE=  .96992333+02, AVERAGE CLOUD CONCENTRATION=  .74639858+00

                                     * X=    600.00 *
**** Y=    345.00, DOSAGE=  .62632401+02, CONCENTRATION=  .98551825+01, TIME AVERAGE CONCENTRATION=  .10438733+00
                   TIME OF PASSAGE=  .97120207+02, AVERAGE CLOUD CONCENTRATION=  .64502849+00

                                     * X=    700.00 *
**** Y=    345.00, DOSAGE=  .56701046+02, CONCENTRATION=  .77935543+01, TIME AVERAGE CONCENTRATION=  .94501743-01
                   TIME OF PASSAGE=  .97227928+02, AVERAGE CLOUD CONCENTRATION=  .58317653+00

                                     * X=    800.00 *
**** Y=    345.00, DOSAGE=  .52784671+02, CONCENTRATION=  .63646967+01, TIME AVERAGE CONCENTRATION=  .87974451-01
                   TIME OF PASSAGE=  .97375417+02, AVERAGE CLOUD CONCENTRATION=  .54207388+00

                                     * X=    900.00 *
**** Y=    345.00, DOSAGE=  .50216701+02, CONCENTRATION=  .53536729+01, TIME AVERAGE CONCENTRATION=  .83694651-01
                   TIME OF PASSAGE=  .97542585+02, AVERAGE CLOUD CONCENTRATION=  .51481915+00

                                     * X=   1000.00 *
**** Y=    345.00, DOSAGE=  .48637203+02, CONCENTRATION=  .46235855+01, TIME AVERAGE CONCENTRATION=  .81062004-01
                   TIME OF PASSAGE=  .97729334+02, AVERAGE CLOUD CONCENTRATION=  .49767251+00

                                     * X=   1250.00 *
**** Y=    345.00, DOSAGE=  .47753183+02, CONCENTRATION=  .35335977+01, TIME AVERAGE CONCENTRATION=  .79588638-01
                   TIME OF PASSAGE=  .98281295+02, AVERAGE CLOUD CONCENTRATION=  .48588571+00

                                     * X=   1500.00 *
**** Y=    345.00, DOSAGE=  .49950964+02, CONCENTRATION=  .29746899+01, TIME AVERAGE CONCENTRATION=  .83251607-01
                   TIME OF PASSAGE=  .98952855+02, AVERAGE CLOUD CONCENTRATION=  .50479762+00

                                     * X=   1750.00 *
**** Y=    345.00, DOSAGE=  .54374653+02, CONCENTRATION=  .26952829+01, TIME AVERAGE CONCENTRATION=  .90624422-01
                   TIME OF PASSAGE=  .99740999+02, AVERAGE CLOUD CONCENTRATION=  .54515856+00

                                     * X=   2000.00 *
**** Y=    345.00, DOSAGE=  .60556230+02, CONCENTRATION=  .25622919+01, TIME AVERAGE CONCENTRATION=  .10092705+00
                   TIME OF PASSAGE=  .10064397+03, AVERAGE CLOUD CONCENTRATION=  .60168758+00

                                     * X=   2500.00 *
**** Y=    345.00, DOSAGE=  .76868046+02, CONCENTRATION=  .25167928+01, TIME AVERAGE CONCENTRATION=  .12611341+00
                   TIME OF PASSAGE=  .10278277+03, AVERAGE CLOUD CONCENTRATION=  .74786351+00

                                     * X=   3000.00 *
**** Y=    345.00, DOSAGE=  .96297305+02, CONCENTRATION=  .25918539+01, TIME AVERAGE CONCENTRATION=  .16049551+00
                   TIME OF PASSAGE=  .10533575+03, AVERAGE CLOUD CONCENTRATION=  .91419393+00

                                     * X=   3500.00 *
**** Y=    345.00, DOSAGE=  .11615332+03, CONCENTRATION=  .26878455+01, TIME AVERAGE CONCENTRATION=  .19358886+00
                   TIME OF PASSAGE=  .10827931+03, AVERAGE CLOUD CONCENTRATION=  .10727194+01
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                                        * X=   4000.00 *
**** Y=    345.00, DOSAGE=  .13405138+03, CONCENTRATION=  .27577925+01, TIME AVERAGE CONCENTRATION=  .22341896+00
                   TIME OF PASSAGE=  .11158971+03, AVERAGE CLOUD CONCENTRATION=  .12013649+01

                                        * X=   5000.00 *
**** Y=    345.00, DOSAGE=  .15855371+03, CONCENTRATION=  .27501485+01, TIME AVERAGE CONCENTRATION=  .26425617+00
                   TIME OF PASSAGE=  .11913485+03, AVERAGE CLOUD CONCENTRATION=  .13308759+01

                                        * X=   6000.00 *
**** Y=    345.00, DOSAGE=  .16698237+03, CONCENTRATION=  .25581052+01, TIME AVERAGE CONCENTRATION=  .27830395+00
                   TIME OF PASSAGE=  .12776617+03, AVERAGE CLOUD CONCENTRATION=  .13069372+01

                                        * X=   7000.00 *
**** Y=    345.00, DOSAGE=  .16382651+03, CONCENTRATION=  .22645865+01, TIME AVERAGE CONCENTRATION=  .27304419+00
                   TIME OF PASSAGE=  .13727163+03, AVERAGE CLOUD CONCENTRATION=  .11934478+01

                                        * X=   8000.00 *
**** Y=    345.00, DOSAGE=  .15452401+03, CONCENTRATION=  .19890841+01, TIME AVERAGE CONCENTRATION=  .25754001+00
                   TIME OF PASSAGE=  .14748239+03, AVERAGE CLOUD CONCENTRATION=  .10477461+01

                                        * X=   9000.00 *
**** Y=    345.00, DOSAGE=  .14301371+03, CONCENTRATION=  .16577530+01, TIME AVERAGE CONCENTRATION=  .23835618+00
                   TIME OF PASSAGE=  .15826175+03, AVERAGE CLOUD CONCENTRATION=  .90365303+00

                                        * X=  10000.00 *
**** Y=    345.00, DOSAGE=  .13151494+03, CONCENTRATION=  .14786329+01, TIME AVERAGE CONCENTRATION=  .21919156+00
                   TIME OF PASSAGE=  .16950157+03, AVERAGE CLOUD CONCENTRATION=  .77589256+00

                                        * X=  12500.00 *
**** Y=    345.00, DOSAGE=  .10757822+03, CONCENTRATION=  .96433819+00, TIME AVERAGE CONCENTRATION=  .17929703+00
                   TIME OF PASSAGE=  .19939589+03, AVERAGE CLOUD CONCENTRATION=  .54033371+00

                                        * X=  15000.00 *
**** Y=    345.00, DOSAGE=  .90549477+02, CONCENTRATION=  .69940645+00, TIME AVERAGE CONCENTRATION=  .15091579+00
                   TIME OF PASSAGE=  .23016079+03, AVERAGE CLOUD CONCENTRATION=  .39341834+00

                                        * X=  17500.00 *
**** Y=    345.00, DOSAGE=  .78142088+02, CONCENTRATION=  .52251548+00, TIME AVERAGE CONCENTRATION=  .13023669+00
                   TIME OF PASSAGE=  .26217409+03, AVERAGE CLOUD CONCENTRATION=  .29805436+00

                                        * X=  20000.00 *
**** Y=    345.00, DOSAGE=  .68720779+02, CONCENTRATION=  .40660295+00, TIME AVERAGE CONCENTRATION=  .11453323+00
                   TIME OF PASSAGE=  .29482676+03, AVERAGE CLOUD CONCENTRATION=  .23308860+00

                                        * X=  25000.00 *
**** Y=    345.00, DOSAGE=  .55364871+02, CONCENTRATION=  .26577380+00, TIME AVERAGE CONCENTRATION=  .92241811-01
                   TIME OF PASSAGE=  .35135872+03, AVERAGE CLOUD CONCENTRATION=  .15321475+00

                                        * X=  30000.00 *
**** Y=    345.00, DOSAGE=  .46353213+02, CONCENTRATION=  .18685421+00, TIME AVERAGE CONCENTRATION=  .77052101-01
                   TIME OF PASSAGE=  .42887094+03, AVERAGE CLOUD CONCENTRATION=  .10807992+00

                                        * X=  35000.00 *
**** Y=    345.00, DOSAGE=  .39863557+02, CONCENTRATION=  .13939599+00, TIME AVERAGE CONCENTRATION=  .65811926-01
                   TIME OF PASSAGE=  .49699389+03, AVERAGE CLOUD CONCENTRATION=  .80209365-01

                                        * X=  40000.00 *
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**** Y=   345.00, DOSAGE=  .34967333+02, CONCENTRATION=  .10655132+00, TIME AVERAGE CONCENTRATION=  .56965560-01
                  TIME OF PASSAGE=  .56548565+03, AVERAGE CLOUD CONCENTRATION=  .61835934-01

                                              * X=  50000.00 *
**** Y=   345.00, DOSAGE=  .28971128+02, CONCENTRATION=  .68687455-01, TIME AVERAGE CONCENTRATION=  .43670787-01
                  TIME OF PASSAGE=  .73315941+03, AVERAGE CLOUD CONCENTRATION=  .39921420-01

                                              * X=  60000.00 *
**** Y=   345.00, DOSAGE=  .23486365+02, CONCENTRATION=  .47899752-01, TIME AVERAGE CONCENTRATION=  .34183783-01
                  TIME OF PASSAGE=  .84137663+03, AVERAGE CLOUD CONCENTRATION=  .27866670-01

                                              * X=  70000.00 *
**** Y=   345.00, DOSAGE=  .20129834+02, CONCENTRATION=  .35291737-01, TIME AVERAGE CONCENTRATION=  .27241580-01
                  TIME OF PASSAGE=  .97990738+03, AVERAGE CLOUD CONCENTRATION=  .20542558-01

                                              * X=  80000.00 *
**** Y=   345.00, DOSAGE=  .17636213+02, CONCENTRATION=  .27278047-01, TIME AVERAGE CONCENTRATION=  .22078348-01
                  TIME OF PASSAGE=  .11186352+04, AVERAGE CLOUD CONCENTRATION=  .15764937-01

                                              * X=  90000.00 *
**** Y=   345.00, DOSAGE=  .15692776+02, CONCENTRATION=  .21828190-01, TIME AVERAGE CONCENTRATION=  .18176122-01
                  TIME OF PASSAGE=  .12574048+04, AVERAGE CLOUD CONCENTRATION=  .12477606-01

                                              * X= 100000.00 *
**** Y=   345.00, DOSAGE=  .14132482+02, CONCENTRATION=  .17773473-01, TIME AVERAGE CONCENTRATION=  .15178174-01
                  TIME OF PASSAGE=  .13964470+04, AVERAGE CLOUD CONCENTRATION=  .10120318-01
-----------------------------------------------------------------------------------------------------------------

                                              ***** LAYER 2 *****

                                               ** INPUT DATA **

 Q=  .34900000+06, UBAR AT BOTTOM=  8.9000, UBAR AT TOP=  9.6000, SIGAK AT BOTTOM= 5.41000, SIGAK AT TOP= 5.05000
SIGEK AT BOTTOM= 5.13000, SIGEK AT TOP= 4.79000, SIGXO=  44.6500, SIGYO=  44.6500, SIGZO=  26.8700, THETAK AT BOTTOM=150.0000
THETAK AT TOP=150.0000, Z=  100.000, ALPHA=1.00, BETA=1.00, H=     .000, DELX=  .00000000   , DELY=  .00000000
IZ400=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =   9.25000, THETA = 150.00000, DELTHP =    .00000, DELU =    .70000
, SIGAP =    .08659, SIGEP =    .08657
-----------------------------------------------------------------------------------------------------------------

                                              ***** LAYER 3 *****

                                               ** INPUT DATA **

 Q=  .96500000+06, UBAR AT BOTTOM=  9.6000, UBAR AT TOP=  9.9000, SIGAK AT BOTTOM= 5.05000, SIGAK AT TOP= 4.85000
SIGEK AT BOTTOM= 4.79000, SIGEK AT TOP= 4.60000, SIGXO=  74.4200, SIGYO=  74.4200, SIGZO=  28.8700, THETAK AT BOTTOM=150.0000
THETAK AT TOP=152.0000, Z=  200.000, ALPHA=1.00, BETA=1.00, H=     .000, DELX=  .00000000   , DELY=  .00000000
IZ400=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =   9.75000, THETA = 151.00000, DELTHP =   2.00000, DELU =    .30000
, SIGAP =    .08196, SIGEP =    .08194
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                              ***** LAYER 4 *****

                               ** INPUT DATA **

Q= .22700000+07, UBAR AT BOTTOM= 9.9000, UBAR AT TOP= 10.2000, SIGAK AT BOTTOM= 4.85000, SIGAK AT TOP= 4.71000
SIGEK AT BOTTOM= 4.60000, SIGEK AT TOP= 4.47000, SIGXO= 104.1900, SIGYO= 104.1900, SIGZO= 28.8700, THETAK AT BOTTOM=152.0000
THETAK AT TOP=153.0000, Z= 300.000, ALPHA=1.00, BETA=1.00, H= .000, DELX= .00000000 , DELY= .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR = 10.05000, THETA = 152.50000, DELTHP = 1.00000, DELU = .30000
, SIGAP = .07914, SIGEP = .07915
---------------------------------------------------------------------------------------------------

                              ***** LAYER 5 *****

                               ** INPUT DATA **

Q= .45500000+07, UBAR AT BOTTOM= 10.2000, UBAR AT TOP= 10.4000, SIGAK AT BOTTOM= 4.71000, SIGAK AT TOP= 4.61000
SIGEK AT BOTTOM= 4.47000, SIGEK AT TOP= 4.37000, SIGXO= 133.9500, SIGYO= 133.9500, SIGZO= 28.8700, THETAK AT BOTTOM=153.0000
THETAK AT TOP=157.0000, Z= 400.000, ALPHA=1.00, BETA=1.00, H= .000, DELX= .00000000 , DELY= .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR = 10.30000, THETA = 155.00000, DELTHP = 4.00000, DELU = .20000
, SIGAP = .07716, SIGEP = .07714
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                              ***** LAYER 6 *****

                               ** INPUT DATA **

Q= .77700000+07, UBAR AT BOTTOM= 10.4000, UBAR AT TOP= 10.6000, SIGAK AT BOTTOM= 4.61000, SIGAK AT TOP= 4.52000
SIGEK AT BOTTOM= 4.37000, SIGEK AT TOP= 4.29000, SIGXO= 163.7200, SIGYO= 163.7200, SIGZO= 28.8700, THETAK AT BOTTOM=157.0000
THETAK AT TOP=160.0000, Z= 500.000, ALPHA=1.00, BETA=1.00, H= .000, DELX= .00000000 , DELY= .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR = 10.50000, THETA = 158.50000, DELTHP = 3.00000, DELU = .20000
, SIGAP = .07558, SIGEP = .07557
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                              ***** LAYER 7 *****

                               ** INPUT DATA **

Q= .11000000+08, UBAR AT BOTTOM= 10.6000, UBAR AT TOP= 10.8000, SIGAK AT BOTTOM= 4.52000, SIGAK AT TOP= 4.45000
SIGEK AT BOTTOM= 4.29000, SIGEK AT TOP= 4.23000, SIGXO= 193.4900, SIGYO= 193.4900, SIGZO= 28.8700, THETAK AT BOTTOM=160.0000
THETAK AT TOP=170.0000, Z= 600.000, ALPHA=1.00, BETA=1.00, H= .000, DELX= .00000000 , DELY= .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR = 10.70000, THETA = 165.00000, DELTHP = 10.00000, DELU = .20000
, SIGAP = .07426, SIGEP = .07435
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                              ***** LAYER 8 *****
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                                   ** INPUT DATA **

 Q=  .13900000+08, UBAR AT BOTTOM= 10.8000, UBAR AT TOP= 10.9000, SIGAK AT BOTTOM= 4.45000, SIGAK AT TOP= 4.39000
SIGEK AT BOTTOM= 4.23000, SIGEK AT TOP= 4.17000, SIGXO= 223.2600, SIGYO= 223.2600, SIGZO=  20.8700, THETAK AT BOTTOM=170.0000
THETAK AT TOP=180.0000, Z=  700.000, ALPHA=1.00, BETA=1.00, H=     .000, DELX=  .00000000   , DELY=  .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =  10.85000, THETA = 175.00000, DELTHP =  10.00000, DELU =    .10000
, SIGAP =    .07318, SIGEP =    .07330
     ------------------------------------------------------------------------------------------------------------

                                  ***** LAYER 9 *****

                                   ** INPUT DATA **

 Q=  .96100000+07, UBAR AT BOTTOM= 10.9000, UBAR AT TOP= 10.0000, SIGAK AT BOTTOM= 4.39000, SIGAK AT TOP= 2.00000
SIGEK AT BOTTOM= 4.17000, SIGEK AT TOP= 1.90000, SIGXO= 182.7700, SIGYO= 182.7700, SIGZO= 144.3400, THETAK AT BOTTOM=180.0000
THETAK AT TOP=228.0000, Z=  900.000, ALPHA=1.00, BETA=1.00, H=     .000, DELX=  .00000000   , DELY=  .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =  10.45000, THETA = 204.00000, DELTHP =  48.00000, DELU =   -.90000
, SIGAP =    .05290, SIGEP =    .05297
     ------------------------------------------------------------------------------------------------------------

         ** CALCULATION HEIGHT Z=  800.000, CLOUD AXIS IS AT  24.000 DEGREES AZIMUTH BEARING RELATIVE TO ORIGIN

                                       * X=    500.00 *
**** Y=     24.00, DOSAGE=  .15896679+04, CONCENTRATION=  .36260032+02, TIME AVERAGE CONCENTRATION=  .26494464+01
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .21137290+02

                                       * X=    600.00 *
**** Y=     24.00, DOSAGE=  .15017753+04, CONCENTRATION=  .34255191+02, TIME AVERAGE CONCENTRATION=  .25029588+01
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .19968612+02

                                       * X=    700.00 *
**** Y=     24.00, DOSAGE=  .14182966+04, CONCENTRATION=  .32351058+02, TIME AVERAGE CONCENTRATION=  .23638276+01
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .18858623+02

                                       * X=    800.00 *
**** Y=     24.00, DOSAGE=  .13400054+04, CONCENTRATION=  .30565252+02, TIME AVERAGE CONCENTRATION=  .22333423+01
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .17817611+02

                                       * X=    900.00 *
**** Y=     24.00, DOSAGE=  .12671885+04, CONCENTRATION=  .28903312+02, TIME AVERAGE CONCENTRATION=  .21119806+01
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .16849388+02

                                       * X=   1000.00 *
**** Y=     24.00, DOSAGE=  .11998184+04, CONCENTRATION=  .27367615+02, TIME AVERAGE CONCENTRATION=  .19996973+01
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .15953590+02

                                       * X=   1250.00 *
**** Y=     24.00, DOSAGE=  .10535672+04, CONCENTRATION=  .24031654+02, TIME AVERAGE CONCENTRATION=  .17559453+01
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .14008936+02

                                       * X=   1500.00 *
```

```
**** Y=     24.00, DOSAGE=  .93454224+03, CONCENTRATION=  .21316719+02, TIME AVERAGE CONCENTRATION=  .15575704+01
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .12426301+02

                                                   * X=   1750.00 *
**** Y=     24.00, DOSAGE=  .83713968+03, CONCENTRATION=  .19094986+02, TIME AVERAGE CONCENTRATION=  .13952328+01
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .11131171+02

                                                   * X=   2000.00 *
**** Y=     24.00, DOSAGE=  .75563646+03, CONCENTRATION=  .17258724+02, TIME AVERAGE CONCENTRATION=  .12610608+01
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .10060746+02

                                                   * X=   2500.00 *
**** Y=     24.00, DOSAGE=  .63347239+03, CONCENTRATION=  .14426565+02, TIME AVERAGE CONCENTRATION=  .10541205+01
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .84097760+01

                                                   * X=   3000.00 *
**** Y=     24.00, DOSAGE=  .54197599+03, CONCENTRATION=  .12362340+02, TIME AVERAGE CONCENTRATION=  .90329166+00
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .72664632+01

                                                   * X=   3500.00 *
**** Y=     24.00, DOSAGE=  .47369526+03, CONCENTRATION=  .10800331+02, TIME AVERAGE CONCENTRATION=  .78915876+00
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .62959105+01

                                                   * X=   4000.00 *
**** Y=     24.00, DOSAGE=  .42004610+03, CONCENTRATION=  .95811666+01, TIME AVERAGE CONCENTRATION=  .70007683+00
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .55852148+01

                                                   * X=   5000.00 *
**** Y=     24.00, DOSAGE=  .34226155+03, CONCENTRATION=  .78069167+01, TIME AVERAGE CONCENTRATION=  .57043591+00
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .45509392+01

                                                   * X=   6000.00 *
**** Y=     24.00, DOSAGE=  .28854210+03, CONCENTRATION=  .65815868+01, TIME AVERAGE CONCENTRATION=  .48090350+00
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .38366493+01

                                                   * X=   7000.00 *
**** Y=     24.00, DOSAGE=  .24929981+03, CONCENTRATION=  .56863729+01, TIME AVERAGE CONCENTRATION=  .41548468+00
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .33147378+01

                                                   * X=   8000.00 *
**** Y=     24.00, DOSAGE=  .21938655+03, CONCENTRATION=  .50041627+01, TIME AVERAGE CONCENTRATION=  .36564424+00
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .29171107+01

                                                   * X=   9000.00 *
**** Y=     24.00, DOSAGE=  .19595954+03, CONCENTRATION=  .44675165+01, TIME AVERAGE CONCENTRATION=  .32643257+00
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .26042799+01

                                                   * X=  10000.00 *
**** Y=     24.00, DOSAGE=  .17697323+03, CONCENTRATION=  .40344427+01, TIME AVERAGE CONCENTRATION=  .29478872+00
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .23518252+01

                                                   * X=  12500.00 *
**** Y=     24.00, DOSAGE=  .14233975+03, CONCENTRATION=  .32467439+01, TIME AVERAGE CONCENTRATION=  .23723292+00
                   TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .18926448+01

                                                   * X=  15000.00 *
**** Y=     24.00, DOSAGE=  .11906982+03, CONCENTRATION=  .27159586+01, TIME AVERAGE CONCENTRATION=  .19844970+00
```

```
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .15832323+01

                                                  * X=  17500.00 *
**** Y=    24.00, DOSAGE=  .12233133+03, CONCENTRATION=  .23341562+01, TIME AVERAGE CONCENTRATION=  .17055216+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .13606656+01

                                                  * X=  20000.00 *
**** Y=    24.00, DOSAGE=  .89715002+02, CONCENTRATION=  .20863810+01, TIME AVERAGE CONCENTRATION=  .14952500+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .11929109+01

                                                  * X=  25000.00 *
**** Y=    24.00, DOSAGE=  .71964569+02, CONCENTRATION=  .16414973+01, TIME AVERAGE CONCENTRATION=  .11994095+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .95608919+00

                                                  * X=  30000.00 *
**** Y=    24.00, DOSAGE=  .60075484+02, CONCENTRATION=  .13703096+01, TIME AVERAGE CONCENTRATION=  .10012581+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .79880393+00

                                                  * X=  35000.00 *
**** Y=    24.00, DOSAGE=  .51556721+02, CONCENTRATION=  .11759984+01, TIME AVERAGE CONCENTRATION=  .85927867-01
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .68555275+00

                                                  * X=  40000.00 *
**** Y=    24.00, DOSAGE=  .45153360+02, CONCENTRATION=  .10299396+01, TIME AVERAGE CONCENTRATION=  .75255600-01
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .60038956+00

                                                  * X=  50000.00 *
**** Y=    24.00, DOSAGE=  .36168388+02, CONCENTRATION=  .82499363+00, TIME AVERAGE CONCENTRATION=  .60280647-01
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .48091916+00

                                                  * X=  60000.00 *
**** Y=    24.00, DOSAGE=  .30165452+02, CONCENTRATION=  .68806785+00, TIME AVERAGE CONCENTRATION=  .50275753-01
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .40110009+00

                                                  * X=  70000.00 *
**** Y=    24.00, DOSAGE=  .25871376+02, CONCENTRATION=  .59012085+00, TIME AVERAGE CONCENTRATION=  .43118960-01
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .34400317+00

                                                  * X=  80000.00 *
**** Y=    24.00, DOSAGE=  .22647425+02, CONCENTRATION=  .51659318+00, TIME AVERAGE CONCENTRATION=  .37745708-01
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .30113535+00

                                                  * X=  90000.00 *
**** Y=    24.00, DOSAGE=  .20137910+02, CONCENTRATION=  .45934165+00, TIME AVERAGE CONCENTRATION=  .33563183-01
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .26776716+00

                                                  * X= 100000.00 *
**** Y=    24.00, DOSAGE=  .18129046+02, CONCENTRATION=  .41351967+00, TIME AVERAGE CONCENTRATION=  .30215077-01
              TIME OF PASSAGE=  .75206795+02, AVERAGE CLOUD CONCENTRATION=  .24105596+00
----------------------------------------------------------------------------------------------------------

                                                  ***** LAYER10 *****

                                                  ** INPUT DATA **

Q=  .54000000+06, UBAR AT BOTTOM= 10.0000, UBAR AT TOP= 11.9000, SIGAK AT BOTTOM= 2.00000, SIGAK AT TOP= 1.00000
```

D.2 EXAMPLE 2 OUTPUT LISTING

Example 2 gives the output listing for the calculation of maximum centerline concentration and centerline dosage using Model 3 for the sea-breeze meteorological regime. Logic Section 2 of the computer program is used in this example. An example problem input coding sheet is shown in Appendix B, Figure B-4. The first part of the output listing has the same form as Example 1 with the exception that summaries of the parameters for all layers are produced before the dosage and concentration tables. This case is explained in full in Section 6 in the main body of the report.

```
NASA/MSFC MULTILAYER DIFFUSION MODEL, VERSION 2  H E CRAMER CO                                DATE 031473

     *-*-* TITLE=CONCENTRATION, NORMAL LAUNCH, SEA BREEZE CASE 2, H=550M,                     ! DATE=MARCH 11 73  *-*--

$NAM2
TESTNO  =      +8930493075,      +27231697748,      +21174236439,      +19432494150,
              +28238207877,      +25939169751,      +19913358152,       +6847749294,
               +5596470640,      +20100436293,       +5453926725,       +5453926725
ISKIP   =               +0,                +0,                +1,                +0,
                        +0,                +0,                +0,                +0,
                        +0,                +0,                +0,                +0,
                        +0,                +0,                +0,                +0,
                        +0,                +0,                +0,                +0,
                        +0,                +0,                +0,                +0,
                        +0,                +0,                +0,                +0,
                        +0,                +0
NXS     =              +34
NYS     =              +37
NZS     =               +2
ND1     =               +0
NC1     =               +0
NDAR    =              +34
NBK     =               +0
NPTS    =               +2
NVS     =               +0
NVB     =               +0
XX      =   .50000000E+03,    .60000000E+03,    .70000000E+03,    .80000000E+03,
            .90000000E+03,    .10000000E+04,    .12500000E+04,    .15000000E+04,
            .17500000E+04,    .20000000E+04,    .25000000E+04,    .30000000E+04,
            .35000000E+04,    .40000000E+04,    .50000000E+04,    .65000000E+04,
            .70000000E+04,    .80000000E+04,    .90000000E+04,    .10000000E+05,
            .12500000E+05,    .15000000E+05,    .17500000E+05,    .20000000E+05,
            .25000000E+05,    .30000000E+05,    .35000000E+05,    .40000000E+05,
            .50000000E+05,    .60000000E+05,    .70000000E+05,    .80000000E+05,
            .90000000E+05,    .10000000E+06,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00,
            .00000000E+00,    .00000000E+00,    .00000000E+00,    .00000000E+00
YY      =   .25500000E+03,    .26000000E+03,    .26500000E+03,    .27000000E+03,
            .27500000E+03,    .28000000E+03,    .28500000E+03,    .29000000E+03,
            .29500000E+03,    .30000000E+03,    .30500000E+03,    .31000000E+03,
            .31500000E+03,    .32000000E+03,    .32500000E+03,    .33000000E+03,
            .33500000E+03,    .34000000E+03,    .34500000E+03,    .35000000E+03,
            .35500000E+03,    .00000000E+00,    .50000000E+01,    .10000000E+02,
            .15000000E+02,    .20000000E+02,    .25000000E+02,    .30000000E+02,
            .35000000E+02,    .40000000E+02,    .45000000E+02,    .50000000E+02,
```

```
            .55000000E+02,  .60000000E+02,  .65000000E+02,  .70000000E+02,
            .75000000E+02,  .80000000E+02,  .85000000E+02,  .90000000E+02,
            .95000000E+02,  .10000000E+03,  .10500000E+03,  .11000000E+03,
            .11500000E+03,  .12000000E+03,  .12500000E+03,  .13000000E+03,
            .13500000E+03,  .14000000E+03,  .14500000E+03,  .15000000E+03,
            .15500000E+03,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
Z       =   .20000000E+01,  .80000000E+03,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00
DXR     =   .50000000E+03,  .60000000E+03,  .70000000E+03,  .80000000E+03,
            .90000000E+03,  .10000000E+04,  .12500000E+04,  .15000000E+04,
            .17500000E+04,  .20000000E+04,  .25000000E+04,  .30000000E+04,
            .35000000E+04,  .40000000E+04,  .50000000E+04,  .60000000E+04,
            .70000000E+04,  .80000000E+04,  .90000000E+04,  .10000000E+05,
            .12500000E+05,  .15000000E+05,  .17500000E+05,  .20000000E+05,
            .25000000E+05,  .30000000E+05,  .35000000E+05,  .40000000E+05,
            .50000000E+05,  .60000000E+05,  .70000000E+05,  .80000000E+05,
            .90000000E+05,  .10000000E+06,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
DELX    =   .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
DELY    =   .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
            .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
```

NASA/MSFC MULTILAYER DIFFUSION MODEL, VERSION 2 H E CRAMER CO   DATE 031473

```
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
Q        =     .41800000E+10,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
UBARK    =     .60000000E+01,  .10900000E+02,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00
SIGAK    =     .80000000E+01,  .43900000E+01,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00
SIGEK    =     .75900000E+01,  .41700000E+01,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00
SIGXO    =     .24800000E+03,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
SIGYO    =     .24800000E+03,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
SIGZO    =     .11600000E+03,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
ALPHA    =     .10000000E+01,  .10000000E+01,  .10000000E+01,  .10000000E+01,
               .10000000E+01,  .10000000E+01,  .10000000E+01,  .10000000E+01,
               .10000000E+01,  .10000000E+01,  .10000000E+01,  .10000000E+01,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00
BETA     =     .10000000E+01,  .10000000E+01,  .10000000E+01,  .10000000E+01,
               .10000000E+01,  .10000000E+01,  .10000000E+01,  .10000000E+01,
               .10000000E+02,  .10000000E+01,  .10000000E+01,  .10000000E+01,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
               .00000000E+00,  .00000000E+00
ZRK      =     .20000000E+01
TIMAV    =     .60000000E+03
```

```
THETAK   =   .15000000E+03,  .18000000E+03,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00
TAUK     =   .46100000E+03
TAUOK    =   .60000000E+03
H        =   .55000000E+03,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
XRY      =   .10000000E+03
XRZ      =   .10000000E+03
XLKY     =   .00000000E+00
XLKZ     =   .00000000E+00
ZZL      =   .20000000E+01,  .55000000E+03,  .00000000E+00,  .00000000E+00,
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             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
IZMOD    =             +3,             +1,             +1,             +1,
                       +1,             +1,             +1,             +1,
                       +1,             +1,             +1,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0
DECAY    =   .00000000E+00
ZLIM     =   .00000000E+00
TIM1     =   .00000000E+00
BLAMDA   =   .00000000E+00
DXR      =   .50000000E+03,  .60000000E+03,  .70000000E+03,  .80000000E+03,
             .90000000E+03,  .10000000E+04,  .12500000E+04,  .15000000E+04,
             .17500000E+04,  .20000000E+04,  .25000000E+04,  .30000000E+04,
             .35000000E+04,  .40000000E+04,  .50000000E+04,  .60000000E+04,
             .70000000E+04,  .80000000E+04,  .90000000E+04,  .10000000E+05,
             .12500000E+05,  .15000000E+05,  .17500000E+05,  .20000000E+05,
```

```
             .25000000E+05,  .30000000E+05,  .35000000E+05,  .40000000E+05,
             .50000000E+05,  .60000000E+05,  .70000000E+05,  .80000000E+05,
             .90000000E+05,  .10000000E+06,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
IFLAG    =             +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0
DI       =   .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00
CI       =   .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00
TAST     =   .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00
JBOT     =             +0,             +0,             +0,             +0,
                       +0,             +0,             +0,             +0,
                       +0,             +0
JTOP     =             +0,             +0,             +0,             +0,
```

```
NASA/MSFC MULTILAYER DIFFUSION MODEL, VERSION 2  H E CRAMER CO                                    DATE 031473
                        +0,                +0,                +0,                +0,
                        +0,                +0
VS       =      .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
PERC     =      .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
ACCUR    =      .20000000E+00
VB       =      .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
PERCB    =      .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
HB       =      .00000000E+00
T        =      .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
DELPHI   =      .18000000E+03
$END

                                        ***** LAYER 1 *****

                                         ** INPUT DATA **

 Q=  .41800000+10, ZRK=  2.000, UBAR AT BOTTOM=  6.0000, UBAR AT TOP= 10.9000, SIGAK AT BOTTOM= 8.00000
SIGAK AT TOP= 4.39000, SIGEK AT BOTTOM= 7.50000, SIGEK AT TOP= 4.17000, TAUK= 461.000, TAUOK= 600.000
SIGXO= 248.0000, SIGYO= 248.0000, SIGZO= 116.0000, THETAK AT BOTTOM=150.0000, THETAK AT TOP=180.0000, Z=    2.000
ALPHA=1.00 BETA=1.00, H=  550.000, DELX=  .0000000   , DELY=  .0000000   , DELPHI=180.0000, IZMOD=3, TIM1=  .00000000
ZLIM=     .000, LAMBDA=  .0000, TIMAV= 600.000, XRY= 100.000, XRZ= 100.000, XLRY=    .000, XLRZ=    .000
 Z AT TOP=  800.0000

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =    9.92348, THETA = 165.00000, DELTHP =  30.00000, DELU =   4.90000
, SIGAP =    .08061, SIGEP =    .08070
       ----------------------------------------------------------------------------------------------------------
```

- MAXIMUM CENTERLINE CONCENTRATION, CENTERLINE DOSAGE, ETC *-*

* CALCULATIONS FOR LAYER 1, AT HEIGHT 2.000 WITH CLOUD AXIS AT 345.000 DEGREES RELATIVE TO SOURCE *

RADIAL DISTANCE	DOSAGE	CONCENTRATION	TIME MEAN ALONGWIND CONCENTRATION	TIME OF PASSAGE	AVERAGE ALONGWIND CONCENTRATION
500.000	.62560589+01	.99658119-01	.10426765-01	.10768784+03	.58094386-01
600.000	.10341019+02	.16457950+00	.17235032-01	.10778693+03	.95939451-01
700.000	.15810616+02	.25135646+00	.26351026-01	.10790393+03	.14652494+00
800.000	.22674070+02	.36002148+00	.37790117-01	.10803876+03	.20986977+00
900.000	.30838928+02	.48897330+00	.51398212-01	.10819137+03	.28504055+00
1000.000	.40131160+02	.63530825+00	.66885266-01	.10836168+03	.37034457+00
1250.000	.66726949+02	.10514634+01	.11121158+00	.10886433+03	.61293676+00
1500.000	.95025331+02	.14890209+01	.15837555+00	.10947554+03	.86800513+00
1750.000	.12175762+03	.18954775+01	.20292936+00	.11019351+03	.11049436+01
2000.000	.14502215+03	.22409213+01	.24170358+00	.11101617+03	.13063156+01
2500.000	.17903295+03	.27187128+01	.29838825+00	.11296611+03	.15848378+01
3000.000	.19845924+03	.29525906+01	.33076539+00	.11530459+03	.17211737+01
3500.000	.20769445+03	.30191870+01	.34615741+00	.11800852+03	.17599953+01
4000.000	.21028192+03	.29799114+01	.35046986+00	.12105342+03	.17371001+01
5000.000	.20389291+03	.27311547+01	.33982151+00	.12806614+03	.15920906+01
6000.000	.18983097+03	.23918593+01	.31638496+00	.13614759+03	.13943028+01
7000.000	.17339902+03	.20497452+01	.28899836+00	.14511933+03	.11948719+01
8000.000	.15738779+03	.17438285+01	.26231297+00	.15482667+03	.10165418+01
9000.000	.14300683+03	.14855360+01	.23834472+00	.16513394+03	.86597364+00
10000.000	.13055238+03	.12728217+01	.21758729+00	.17595262+03	.74197462+00
12500.000	.10671612+03	.89457137+00	.17786020+00	.20464142+03	.52147859+00
15000.000	.90124951+02	.65790379+00	.15020824+00	.23499637+03	.38351635+00
17500.000	.77981696+02	.50206237+00	.12996932+00	.26644864+03	.29267064+00
20000.000	.68715870+02	.39470307+00	.11452464+00	.29865174+03	.23008695+00
25000.000	.55513409+02	.26125594+00	.92485166-01	.36451066+03	.15229571+00
30000.000	.46562031+02	.18508181+00	.77386275-01	.43156548+03	.10789100+00
35000.000	.40094613+02	.13774404+00	.66170684-01	.49933466+03	.80296074-01
40000.000	.35203745+02	.10640298+00	.57321457-01	.56756236+03	.62026215-01
50000.000	.28298446+02	.68871289-01	.43993348-01	.70486002+03	.40147610-01
60000.000	.23657515+02	.48151659-01	.34466026-01	.84282301+03	.28069375-01
70000.000	.20323930+02	.35533798-01	.27485009-01	.98117071+03	.20713959-01
80000.000	.17813648+02	.27290169-01	.22287610-01	.11197605+04	.15908444-01
90000.000	.15855322+02	.21612054-01	.18356392-01	.12585125+04	.12598462-01
100000.000	.14284822+02	.17536355-01	.15334150-01	.13973783+04	.10222587-01

* CALCULATIONS FOR LAYER 1, AT HEIGHT 550.000 WITH CLOUD AXIS AT 345.000 DEGREES RELATIVE TO SOURCE *

RADIAL DISTANCE	DOSAGE	CONCENTRATION	TIME MEAN ALONGWIND CONCENTRATION	TIME OF PASSAGE	AVERAGE ALONGWIND CONCENTRATION
500.000	.14639155+04	.23319964+02	.24398592+01	.10768784+03	.13594066+02
600.000	.13489127+04	.21468230+02	.22481878+01	.10778693+03	.12514622+02
700.000	.12478319+04	.19837976+02	.20797198+01	.10790393+03	.11564286+02
800.000	.11588632+04	.18400562+02	.19314386+01	.10803876+03	.10726365+02
900.000	.10803940+04	.17130421+02	.18006566+01	.10819137+03	.99859531+01
1000.000	.10109940+04	.16004841+02	.16849901+01	.10836168+03	.93298113+01
1250.000	.86930105+03	.13698186+02	.14488351+01	.10886433+03	.79851781+01
1500.000	.76130714+03	.11929475+02	.12688452+01	.10947554+03	.69541299+01
1750.000	.67642518+03	.10530337+02	.11273753+01	.11019351+03	.61385211+01
2000.000	.60769870+03	.93903241+01	.10128312+01	.11101617+03	.54739657+01
2500.000	.50232015+03	.76280047+01	.83720025+00	.11296611+03	.44466448+01

NASA/MSFC MULTILAYER MODEL

3000.000	.42482978+03	.63204336+01	.70804964+00	.11530459+03	.36844134+01
3500.000	.36570720+03	.53161674+01	.60951199+00	.11800852+03	.30989897+01
4000.000	.31964663+03	.45297222+01	.53274438+00	.12105342+03	.26405418+01
5000.000	.25414198+03	.34042433+01	.42356997+00	.12806614+03	.19844587+01
6000.000	.21131604+03	.26625698+01	.35219339+00	.13614759+03	.15521099+01
7000.000	.18186620+03	.21498354+01	.30311032+00	.14511933+03	.12532182+01
8000.000	.16044834+03	.17777389+01	.26741389+00	.15482667+03	.10363094+01
9000.000	.14401932+03	.14960536+01	.24003220+00	.16513994+03	.87210473+00
10000.000	.13086019+03	.12758227+01	.21810031+00	.17595262+03	.74372402+00
12500.000	.10672587+03	.89465310+00	.17787645+00	.20464142+03	.52152623+00
15000.000	.90125113+02	.65790498+00	.15020851+00	.23499637+03	.38351704+00
17500.000	.77981261+02	.50205956+00	.12996859+00	.26644864+03	.29266901+00
20000.000	.68715819+02	.39470278+00	.11452455+00	.29865174+03	.23008678+00
25000.000	.55513342+02	.26125562+00	.92485053-01	.36451066+03	.15229552+00
30000.000	.46561960+02	.18508152+00	.77386157-01	.43156548+03	.10789084+00
35000.000	.40094543+02	.13774380+00	.66170569-01	.49933466+03	.80295933-01
40000.000	.35203935+02	.10640355+00	.57321766-01	.56756236+03	.62026550-01
50000.000	.28298681+02	.68871861-01	.43993714-01	.70486002+03	.40147944-01
60000.000	.23657505+02	.48151638-01	.34466010-01	.84282301+03	.28069363-01
70000.000	.20323919+02	.35533779-01	.27484994-01	.98117071+03	.20713948-01
80000.000	.17813732+02	.27290298-01	.22287716-01	.11197605+04	.15908520-01
90000.000	.15855318+02	.21612049-01	.18356388-01	.12585125+04	.12598459-01
100000.000	.14284819+02	.17536352-01	.15334147-01	.13973783+04	.10222585-01

D.3 EXAMPLE 3 OUTPUT LISTING

Example 3 is an output listing of dosage and concentration, for the sea-breeze meteorological regime, over a 180-degree sector about the alongwind cloud axis. Values in this listing at YY = 345 degrees are the same as those listed in Example 1.

```
         *-*-* TITLE=CONCENTRATION, NORMAL LAUNCH, SEA BREEZE CASE 1, H=832M,                 ; DATE=MARCH 11 73  *-*-*

$NAM2
TESTNO   =     +8930493075,    +27231597748,    +21174236439,    +19432494150,
              +28238207677,    +25939169751,    +10913353152,     +6847749230,
               +5596482802,    +20100436293,     +5453926725,     +5453926725
ISKIP    =              +0,              +1,              +0,              +0,
                        +0,              +0,              +0,              +0,
                        +0,              +0,              +0,              +0,
                        +0,              +0,              +0,              +0,
                        +0,              +0,              +0,              +0,
                        +0,              +0,              +0,              +0,
                        +0,              +0,              +0,              +0,
                        +0,              +0
NXS      =             +34
NYS      =             +53
NZS      =             +12
ND1      =              +0
NC1      =              +0
NDXR     =             +34
NBK      =              +1
NPTS     =              +4
NVS      =              +0
NVB      =              +0
XX       =   .50000000E+03,  .60000000E+03,  .70000000E+03,  .80000000E+03,
             .90000000E+03,  .10000000E+04,  .12500000E+04,  .15000000E+04,
             .17500000E+04,  .20000000E+04,  .25000000E+04,  .30000000E+04,
             .35000000E+04,  .40000000E+04,  .50000000E+04,  .60000000E+04,
             .70000000E+04,  .80000000E+04,  .90000000E+04,  .10000000E+05,
             .12500000E+05,  .15000000E+05,  .17500000E+05,  .20000000E+05,
             .25000000E+05,  .30000000E+05,  .35000000E+05,  .40000000E+05,
             .50000000E+05,  .60000000E+05,  .70000000E+05,  .80000000E+05,
             .90000000E+05,  .10000000E+06,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
             .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
YY       =   .25500000E+03,  .26000000E+03,  .26500000E+03,  .27000000E+03,
             .27500000E+03,  .28000000E+03,  .28500000E+03,  .29000000E+03,
             .29500000E+03,  .30000000E+03,  .30500000E+03,  .31000000E+03,
             .31500000E+03,  .32000000E+03,  .32500000E+03,  .33000000E+03,
             .33500000E+03,  .34000000E+03,  .34500000E+03,  .35000000E+03,
             .35500000E+03,  .00000000E+00,  .50000000E+01,  .10000000E+02,
             .15000000E+02,  .20000000E+02,  .25000000E+02,  .30000000E+02,
             .35000000E+02,  .40000000E+02,  .45000000E+02,  .50000000E+02,
```

```
           .55000000E+02,  .60000000E+02,  .65000000E+02,  .70000000E+02,
           .75000000E+02,  .80000000E+02,  .85000000E+02,  .90000000E+02,
           .95000000E+02,  .10000000E+03,  .10500000E+03,  .11000000E+03,
           .11500000E+03,  .12000000E+03,  .12500000E+03,  .13000000E+03,
           .13500000E+03,  .14000000E+03,  .14500000E+03,  .15000000E+03,
           .15500000E+03,  .00000000E+00,  .00000000E+00,  .00000000E+00,
           .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
           .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
           .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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           .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
           .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
Z     =    .20000000E+01,  .10000000E+03,  .20000000E+03,  .30000000E+03,
           .40000000E+03,  .50000000E+03,  .60000000E+03,  .70000000E+03,
           .80000000E+03,  .13000000E+04,  .18000000E+04,  .22000000E+04,
           .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
           .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
           .00000000E+00
DXH   =    .50000000E+03,  .60000000E+03,  .70000000E+03,  .80000000E+03,
           .90000000E+03,  .10000000E+04,  .12500000E+04,  .15000000E+04,
           .17500000E+04,  .20000000E+04,  .25000000E+04,  .30000000E+04,
           .35000000E+04,  .40000000E+04,  .50000000E+04,  .60000000E+04,
           .70000000E+04,  .80000000E+04,  .90000000E+04,  .10000000E+05,
           .12500000E+05,  .15000000E+05,  .17500000E+05,  .20000000E+05,
           .25000000E+05,  .30000000E+05,  .35000000E+05,  .40000000E+05,
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DELX  =    .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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DELY  =    .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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           .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
```

```
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
Q        =      .14400000E+06,  .34900000E+06,  .96600000E+06,  .22700000E+07,
                .45500000E+07,  .77700000E+07,  .11300000E+08,  .13900000E+08,
                .96100000E+07,  .54000000E+06,  .10700000E+04,  .00000000E+00,
                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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UBARK    =      .60000000E+01,  .89000000E+01,  .96000000E+01,  .99000000E+01,
                .10200000E+02,  .10400000E+02,  .10600000E+02,  .10800000E+02,
                .10900000E+02,  .10000000E+02,  .11900000E+02,  .13000000E+02,
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                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00
SIGAK    =      .80000000E+01,  .54100000E+01,  .50500000E+01,  .48500000E+01,
                .47100000E+01,  .46100000E+01,  .45200000E+01,  .44500000E+01,
                .43900000E+01,  .20000000E+01,  .10000000E+01,  .10000000E+01,
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SIGEK    =      .75900000E+01,  .51300000E+01,  .47900000E+01,  .46000000E+01,
                .44700000E+01,  .43700000E+01,  .42900000E+01,  .42300000E+01,
                .41700000E+01,  .19000000E+01,  .95000000E+00,  .95000000E+00,
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                .00000000E+00
SIGXO    =      .14680000E+02,  .44650000E+02,  .74420000E+02,  .10419000E+03,
                .13395000E+03,  .16372000E+03,  .19349000E+03,  .22326000E+03,
                .18277000E+03,  .93000000E+02,  .93000000E+02,  .00000000E+00,
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                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00
SIGYO    =      .14680000E+02,  .44650000E+02,  .74420000E+02,  .10419000E+03,
                .13395000E+03,  .16372000E+03,  .19349000E+03,  .22326000E+03,
                .18277000E+03,  .93000000E+02,  .93000000E+02,  .00000000E+00,
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SIGZO    =      .28870000E+02,  .28870000E+02,  .28870000E+02,  .28870000E+02,
                .28870000E+02,  .28870000E+02,  .28870000E+02,  .28870000E+02,
                .14434000E+03,  .14434000E+03,  .11547000E+03,  .00000000E+00,
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ALPHA    =      .10000000E+01,  .10000000E+01,  .10000000E+01,  .10000000E+01,
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                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00
BETA     =      .10000000E+01,  .10000000E+01,  .10000000E+01,  .10000000E+01,
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                .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
                .00000000E+00,  .00000000E+00
ZRK      =      .20000000E+01
TIMAV    =      .60000000E+03
```

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THETAK  =  .15000000E+03,  .15000000E+03,  .15000000E+03,  .15200000E+03,
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TAUK    =  .46100000E+03
TAUOK   =  .60000000E+03
H       =  .00000000E+00,  .00000000E+00,  .00000000E+00,  .00000000E+00,
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XRY     =  .10000000E+03
XRZ     =  .10000000E+03
XLRY    =  .00000000E+00
XLRZ    =  .00000000E+00
ZZL     =  .20000000E+01,  .80000000E+03,  .13000000E+04,  .18000000E+04,
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IZMOD   =             +1,             +1,             +1,             +1,
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                      +1,             +1,             +1,             +0,
                      +0,             +0,             +0,             +0,
                      +0,             +0,             +0,             +0
DECAY   =  .00000000E+00
ZLIM    =  .00000000E+00
TIM1    =  .00000000E+00
BLAMDA  =  .00000000E+00
DXR     =  .50000000E+03,  .60000000E+03,  .70000000E+03,  .80000000E+03,
           .90000000E+03,  .10000000E+04,  .12500000E+04,  .15000000E+04,
           .17500000E+04,  .20000000E+04,  .25000000E+04,  .30000000E+04,
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           .70000000E+04,  .80000000E+04,  .90000000E+04,  .10000000E+05,
           .12500000E+05,  .15000000E+05,  .17500000E+05,  .20000000E+05,
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IFLAG    =                +0,              +0,              +0,              +0,
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                          +0,              +0,              +0,              +0,
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                          +0,              +0,              +0,              +0,
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                          +0,              +0,              +0,              +0,
                          +0,              +0,              +0,              +0,
                          +0,              +0,              +0,              +0
DI       =      .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
                .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
                .00000000E+00,   .00000000E+00
CI       =      .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
                .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
                .00000000E+00,   .00000000E+00
TAST     =      .10000000E+01,   .00000000E+00,   .00000000E+00,   .00000000E+00,
                .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
                .00000000E+00,   .00000000E+00
JBOT     =                +1,              +0,              +0,              +0,
                          +0,              +0,              +0,              +0,
                          +0,              +0
JTOP     =                +8,              +0,              +0,              +0,
```

```
                  +0,               +0,               +0,               +0,
                  +0,               +0
VS       =   .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
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             .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00
PERC     =   .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
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             .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00
ACCUR    =   .00000000E+00
VB       =   .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
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             .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00
PERCB    =   .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
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             .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
             .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00
HB       =   .00000000E+00
T        =   .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
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             .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
             .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00,
             .00000000E+00,   .00000000E+00,   .00000000E+00,   .00000000E+00
DELPHI   =   .18000000E+03
$END

                              ***** LAYER 1 *****

                                ** INPUT DATA **

 Q=  .14400000+06, ZRK=  2.000, UBAR AT BOTTOM=  6.0000, UBAR AT TOP=  8.9000, SICAK AT BOTTOM= 8.00000
SIGAK AT TOP= 5.41000, SIGEK AT BOTTOM= 7.59000, SIGEK AT TOP= 5.13000, TAUK= 461.000, TAUOK= 600.000
SIGXO=  14.8000, SIGYO=  14.8000, SIGZO=  28.8700, THETAK AT BOTTOM=150.0000, THETAK AT TOP=150.0000, Z=    2.000
ALPHA=1.00 BETA=1.00, H=      .000, DELX=  .00000000    , DELY=  .00000000    , DELPHI=180.0000, IZMOD=1, TIMI=  .00000000
ZLIM=      .000, LAMBDA=  .0000, TIMAV= 600.000, XRY= 100.000, XRZ= 100.000, XLRY=     .000, XLRZ=     .000

 ZRL=  2.000, UBARL AT BOTTOM=  6.0000, UBARL AT TOP= 10.9000, SIGAL AT BOTTOM= 8.00000, SIGAL AT TOP= 4.39000
SIGEL AT BOTTOM= 7.59000, SIGEL AT TOP= 4.17000, THETAL AT BOTTOM=150.0000, THETAL AT TOP=180.0000, TAUL= 461.000
TAUOL= 600.000, ALPHL=1.00, BETL=1.00, TAST=  .10000000+01, JBOT= 1, JTOP= 8

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =   8.13087, THETA = 150.00000, DELTHP =     .00000, DELU =   2.90000
, SIGAP =    .09855, SIGEP =    .09852

CALCULATED INPUT PARAMETERS FOR LAYER CHANGE MODELS **** UBAR =   9.92348, THETA = 165.00000, DELTHP =  30.00000
  DELU =   4.90000, SIGAP =    .08061, SIGEP =    .08070
  ---------------------------------------------------------------------------------------------------
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                              *-* DOSAGE AND CONCENTRATION PATTERNS *-*

           ** CALCULATION HEIGHT Z=    2.000, CLOUD AXIS IS AT 345.000 DEGREES AZIMUTH BEARING RELATIVE TO ORIGIN

                                            * X=    500.00 *
** Y=   255.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   260.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   265.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   270.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   275.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   280.000, DOSAGE=  .16279216-24, CONCENTRATION=  .39524318-25, TIME MEAN ALONGWIND CONCENTRATION=  .27132026-27
             TIME OF PASSAGE=  .96792819+02, AVERAGE ALONGWIND CONCENTRATION=  .16618019-26
** Y=   285.000, DOSAGE=  .11194078-11, CONCENTRATION=  .97676286-13, TIME MEAN ALONGWIND CONCENTRATION=  .18656797-14
             TIME OF PASSAGE=  .96809886+02, AVERAGE ALONGWIND CONCENTRATION=  .11562949-13
** Y=   290.000, DOSAGE=  .12430934-08, CONCENTRATION=  .10818465-09, TIME MEAN ALONGWIND CONCENTRATION=  .20718223-11
             TIME OF PASSAGE=  .96828894+02, AVERAGE ALONGWIND CONCENTRATION=  .12838042-10
** Y=   295.000, DOSAGE=  .23707665-06, CONCENTRATION=  .21673796-07, TIME MEAN ALONGWIND CONCENTRATION=  .39512775-09
             TIME OF PASSAGE=  .96849245+02, AVERAGE ALONGWIND CONCENTRATION=  .24478938-08
** Y=   300.000, DOSAGE=  .16780408-04, CONCENTRATION=  .20213679-05, TIME MEAN ALONGWIND CONCENTRATION=  .27967347-07
             TIME OF PASSAGE=  .96870387+02, AVERAGE ALONGWIND CONCENTRATION=  .17322551-06
** Y=   305.000, DOSAGE=  .73596442-03, CONCENTRATION=  .11925857-03, TIME MEAN ALONGWIND CONCENTRATION=  .12266074-05
             TIME OF PASSAGE=  .96891421+02, AVERAGE ALONGWIND CONCENTRATION=  .75957685-05
** Y=   310.000, DOSAGE=  .18170662-01, CONCENTRATION=  .32909703-02, TIME MEAN ALONGWIND CONCENTRATION=  .30284436-04
             TIME OF PASSAGE=  .96911932+02, AVERAGE ALONGWIND CONCENTRATION=  .18749664-03
** Y=   315.000, DOSAGE=  .23095722+00, CONCENTRATION=  .42881623-01, TIME MEAN ALONGWIND CONCENTRATION=  .38492871-03
             TIME OF PASSAGE=  .96931256+02, AVERAGE ALONGWIND CONCENTRATION=  .23826922-02
** Y=   320.000, DOSAGE=  .16301402+01, CONCENTRATION=  .30218412+00, TIME MEAN ALONGWIND CONCENTRATION=  .27169003-02
             TIME OF PASSAGE=  .96948645+02, AVERAGE ALONGWIND CONCENTRATION=  .16814471-01
** Y=   325.000, DOSAGE=  .70736573+01, CONCENTRATION=  .12998890+01, TIME MEAN ALONGWIND CONCENTRATION=  .11789429-01
             TIME OF PASSAGE=  .96963711+02, AVERAGE ALONGWIND CONCENTRATION=  .72951594-01
** Y=   330.000, DOSAGE=  .20485622+02, CONCENTRATION=  .37292478+01, TIME MEAN ALONGWIND CONCENTRATION=  .34142703-01
             TIME OF PASSAGE=  .96975939+02, AVERAGE ALONGWIND CONCENTRATION=  .21126458+00
** Y=   335.000, DOSAGE=  .41996499+02, CONCENTRATION=  .75866992+01, TIME MEAN ALONGWIND CONCENTRATION=  .69994165-01
             TIME OF PASSAGE=  .96984953+02, AVERAGE ALONGWIND CONCENTRATION=  .43302077+00
** Y=   340.000, DOSAGE=  .63340173+02, CONCENTRATION=  .11386429+02, TIME MEAN ALONGWIND CONCENTRATION=  .10556695+00
             TIME OF PASSAGE=  .96990474+02, AVERAGE ALONGWIND CONCENTRATION=  .65305560+00
** Y=   345.000, DOSAGE=  .71812986+02, CONCENTRATION=  .12887471+02, TIME MEAN ALONGWIND CONCENTRATION=  .11968831+00
             TIME OF PASSAGE=  .96992333+02, AVERAGE ALONGWIND CONCENTRATION=  .74039858+00
** Y=   350.000, DOSAGE=  .61617002+02, CONCENTRATION=  .11075377+02, TIME MEAN ALONGWIND CONCENTRATION=  .10269500+00
             TIME OF PASSAGE=  .96990474+02, AVERAGE ALONGWIND CONCENTRATION=  .63528921+00
** Y=   355.000, DOSAGE=  .39708845+02, CONCENTRATION=  .71715687+01, TIME MEAN ALONGWIND CONCENTRATION=  .66181408-01
             TIME OF PASSAGE=  .96984953+02, AVERAGE ALONGWIND CONCENTRATION=  .40943305+00
** Y=      .000, DOSAGE=  .18792095+02, CONCENTRATION=  .34193257+01, TIME MEAN ALONGWIND CONCENTRATION=  .31320158-01
             TIME OF PASSAGE=  .96975939+02, AVERAGE ALONGWIND CONCENTRATION=  .19378101+00
** Y=     5.000, DOSAGE=  .62777928+01, CONCENTRATION=  .11526417+01, TIME MEAN ALONGWIND CONCENTRATION=  .10462988-01
             TIME OF PASSAGE=  .96963711+02, AVERAGE ALONGWIND CONCENTRATION=  .64743735-01
** Y=    10.000, DOSAGE=  .13945373+01, CONCENTRATION=  .25809481+00, TIME MEAN ALONGWIND CONCENTRATION=  .23242289-02
             TIME OF PASSAGE=  .96948645+02, AVERAGE ALONGWIND CONCENTRATION=  .14384289-01
** Y=    15.000, DOSAGE=  .18961070+00, CONCENTRATION=  .35980815-01, TIME MEAN ALONGWIND CONCENTRATION=  .31601783-03
             TIME OF PASSAGE=  .96931236+02, AVERAGE ALONGWIND CONCENTRATION=  .19561368-02
** Y=    20.000, DOSAGE=  .14282174-01, CONCENTRATION=  .25643749-02, TIME MEAN ALONGWIND CONCENTRATION=  .23803624-04
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                TIME OF PASSAGE=  .96911932+02, AVERAGE ALONGWIND CONCENTRATION=  .14737271-03
** Y=   25.000, DOSAGE=  .55878935-03, CONCENTRATION=  .88554855-04, TIME MEAN ALONGWIND CONCENTRATION=  .93131558-06
                TIME OF PASSAGE=  .96891421+02, AVERAGE ALONGWIND CONCENTRATION=  .57671705-05
** Y=   30.000, DOSAGE=  .12668209-04, CONCENTRATION=  .14744690-05, TIME MEAN ALONGWIND CONCENTRATION=  .21113682-07
                TIME OF PASSAGE=  .96870307+02, AVERAGE ALONGWIND CONCENTRATION=  .13077494-06
** Y=   35.000, DOSAGE=  .17606093-06, CONCENTRATION=  .15091777-07, TIME MEAN ALONGWIND CONCENTRATION=  .29476821-09
                TIME OF PASSAGE=  .96849245+02, AVERAGE ALONGWIND CONCENTRATION=  .18261467-08
** Y=   40.000, DOSAGE=  .88303012-09, CONCENTRATION=  .76803394-10, TIME MEAN ALONGWIND CONCENTRATION=  .14717169-11
                TIME OF PASSAGE=  .96828894+02, AVERAGE ALONGWIND CONCENTRATION=  .91194699-11
** Y=   45.000, DOSAGE=  .74330836-12, CONCENTRATION=  .64858597-13, TIME MEAN ALONGWIND CONCENTRATION=  .12388473-14
                TIME OF PASSAGE=  .96809886+02, AVERAGE ALONGWIND CONCENTRATION=  .76780211-14
** Y=   50.000, DOSAGE=  .50802372-25, CONCENTRATION=  .12338314-25, TIME MEAN ALONGWIND CONCENTRATION=  .84670620-28
                TIME OF PASSAGE=  .96792819+02, AVERAGE ALONGWIND CONCENTRATION=  .52485683-27
** Y=   55.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   60.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   65.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   70.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   75.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   80.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   85.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   90.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   95.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  100.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  105.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  110.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  115.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  120.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  125.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  130.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  135.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  140.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  145.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  150.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  155.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000

                                        * X=    600.00 *
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** Y=    255.000, DOSAGE= .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE= .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    260.000, DOSAGE= .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE= .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    265.000, DOSAGE= .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE= .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    270.000, DOSAGE= .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE= .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    275.000, DOSAGE= .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE= .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    280.000, DOSAGE= .54234442-16, CONCENTRATION=  .47302150-17, TIME MEAN ALONGWIND CONCENTRATION=  .90390737-19
             TIME OF PASSAGE= .96811612+02, AVERAGE ALONGWIND CONCENTRATION=  .56020596-18
** Y=    285.000, DOSAGE= .11348963-11, CONCENTRATION=  .98371389-13, TIME MEAN ALONGWIND CONCENTRATION=  .18914937-14
             TIME OF PASSAGE= .96836381+02, AVERAGE ALONGWIND CONCENTRATION=  .11719730-13
** Y=    290.000, DOSAGE= .14978357-08, CONCENTRATION=  .12896805-09, TIME MEAN ALONGWIND CONCENTRATION=  .24963928-11
             TIME OF PASSAGE= .96863931+02, AVERAGE ALONGWIND CONCENTRATION=  .15463296-10
** Y=    295.000, DOSAGE= .32945800-06, CONCENTRATION=  .28364063-07, TIME MEAN ALONGWIND CONCENTRATION=  .54909667-09
             TIME OF PASSAGE= .96893495+02, AVERAGE ALONGWIND CONCENTRATION=  .34002108-08
** Y=    300.000, DOSAGE= .21946110-04, CONCENTRATION=  .20242353-05, TIME MEAN ALONGWIND CONCENTRATION=  .36576850-07
             TIME OF PASSAGE= .96923883+02, AVERAGE ALONGWIND CONCENTRATION=  .22642524-06
** Y=    305.000, DOSAGE= .71738277-03, CONCENTRATION=  .82307178-04, TIME MEAN ALONGWIND CONCENTRATION=  .11956379-05
             TIME OF PASSAGE= .96954421+02, AVERAGE ALONGWIND CONCENTRATION=  .73991754-05
** Y=    310.000, DOSAGE= .14625864-01, CONCENTRATION=  .20443851-02, TIME MEAN ALONGWIND CONCENTRATION=  .24376440-04
             TIME OF PASSAGE= .96984074+02, AVERAGE ALONGWIND CONCENTRATION=  .15080086-03
** Y=    315.000, DOSAGE= .17885983+00, CONCENTRATION=  .27444693-01, TIME MEAN ALONGWIND CONCENTRATION=  .29809972-03
             TIME OF PASSAGE= .97011926+02, AVERAGE ALONGWIND CONCENTRATION=  .18453491-02
** Y=    320.000, DOSAGE= .12881826+01, CONCENTRATION=  .20386957+00, TIME MEAN ALONGWIND CONCENTRATION=  .21469709-02
             TIME OF PASSAGE= .97037119+02, AVERAGE ALONGWIND CONCENTRATION=  .13275153-01
** Y=    325.000, DOSAGE= .57693762+01, CONCENTRATION=  .91860414+00, TIME MEAN ALONGWIND CONCENTRATION=  .96156265-02
             TIME OF PASSAGE= .97058879+02, AVERAGE ALONGWIND CONCENTRATION=  .59442021-01
** Y=    330.000, DOSAGE= .17180226+02, CONCENTRATION=  .27288673+01, TIME MEAN ALONGWIND CONCENTRATION=  .28633710-01
             TIME OF PASSAGE= .97076537+02, AVERAGE ALONGWIND CONCENTRATION=  .17697539+00
** Y=    335.000, DOSAGE= .35953714+02, CONCENTRATION=  .56946594+01, TIME MEAN ALONGWIND CONCENTRATION=  .59922856-01
             TIME OF PASSAGE= .97089551+02, AVERAGE ALONGWIND CONCENTRATION=  .37031497+00
** Y=    340.000, DOSAGE= .54935836+02,,CONCENTRATION=  .86557302+01, TIME MEAN ALONGWIND CONCENTRATION=  .91559727-01
             TIME OF PASSAGE= .97097523+02, AVERAGE ALONGWIND CONCENTRATION=  .56575000+00
** Y=    345.000, DOSAGE= .62632401+02, CONCENTRATION=  .98851825+01, TIME MEAN ALONGWIND CONCENTRATION=  .10438733+00
             TIME OF PASSAGE= .97100207+02, AVERAGE ALONGWIND CONCENTRATION=  .64502549+00
** Y=    350.000, DOSAGE= .53653356+02, CONCENTRATION=  .84517833+01, TIME MEAN ALONGWIND CONCENTRATION=  .89422259-01
             TIME OF PASSAGE= .97097523+02, AVERAGE ALONGWIND CONCENTRATION=  .55257183+00
** Y=    355.000, DOSAGE= .34272252+02, CONCENTRATION=  .54161063+01, TIME MEAN ALONGWIND CONCENTRATION=  .57120416-01
             TIME OF PASSAGE= .97089551+02, AVERAGE ALONGWIND CONCENTRATION=  .35299627+00
** Y=       .000, DOSAGE= .15959554+02, CONCENTRATION=  .25322831+01, TIME MEAN ALONGWIND CONCENTRATION=  .26599257-01
             TIME OF PASSAGE= .97076536+02, AVERAGE ALONGWIND CONCENTRATION=  .16440177+00
** Y=      5.000, DOSAGE= .52116739+01, CONCENTRATION=  .82843207+00, TIME MEAN ALONGWIND CONCENTRATION=  .86851217-02
             TIME OF PASSAGE= .97058879+02, AVERAGE ALONGWIND CONCENTRATION=  .53695994-01
** Y=     10.000, DOSAGE= .11290439+01, CONCENTRATION=  .17813150+00, TIME MEAN ALONGWIND CONCENTRATION=  .18817399-02
             TIME OF PASSAGE= .97037118+02, AVERAGE ALONGWIND CONCENTRATION=  .11635176-01
** Y=     15.000, DOSAGE= .15179856+00, CONCENTRATION=  .23149081-01, TIME MEAN ALONGWIND CONCENTRATION=  .25299761-03
             TIME OF PASSAGE= .97011925+02, AVERAGE ALONGWIND CONCENTRATION=  .15647413-02
** Y=     20.000, DOSAGE= .12046283-01, CONCENTRATION=  .16632791-02, TIME MEAN ALONGWIND CONCENTRATION=  .20077139-04
             TIME OF PASSAGE= .96984074+02, AVERAGE ALONGWIND CONCENTRATION=  .12420858-03
** Y=     25.000, DOSAGE= .57795781-03, CONCENTRATION=  .64938587-04, TIME MEAN ALONGWIND CONCENTRATION=  .96326301-06
             TIME OF PASSAGE= .96954421+02, AVERAGE ALONGWIND CONCENTRATION=  .59611289-05
** Y=     30.000, DOSAGE= .17275420-04, CONCENTRATION=  .15791289-05, TIME MEAN ALONGWIND CONCENTRATION=  .28792366-07
             TIME OF PASSAGE= .96923883+02, AVERAGE ALONGWIND CONCENTRATION=  .17623697-06
** Y=     35.000, DOSAGE= .24865899-06, CONCENTRATION=  .21383195-07, TIME MEAN ALONGWIND CONCENTRATION=  .41443165-09
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              TIME OF PASSAGE=  .96893405+02, AVERAGE ALONGWIND CONCENTRATION=  .25663149-08
** Y=     40.000, DOSAGE=  .10654675-08, CONCENTRATION=  .91737054-10, TIME MEAN ALONGWIND CONCENTRATION=  .17757791-11
              TIME OF PASSAGE=  .96863931+02, AVERAGE ALONGWIND CONCENTRATION=  .10999631-10
** Y=     45.000, DOSAGE=  .74950441-12, CONCENTRATION=  .64966196-13, TIME MEAN ALONGWIND CONCENTRATION=  .12491740-14
              TIME OF PASSAGE=  .96836380+02, AVERAGE ALONGWIND CONCENTRATION=  .77399052-14
** Y=     50.000, DOSAGE=  .32637115-16, CONCENTRATION=  .28465420-17, TIME MEAN ALONGWIND CONCENTRATION=  .54395192-19
              TIME OF PASSAGE=  .95811611+02, AVERAGE ALONGWIND CONCENTRATION=  .33711984-16
** Y=     55.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=     60.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=     65.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=     70.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=     75.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=     80.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=     85.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=     90.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=     95.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    100.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    105.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    110.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    115.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    120.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    125.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    130.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    135.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    140.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    145.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    150.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    155.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000

                                        * X=    700.00 *
** Y=    255.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    260.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    265.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
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** Y=   270.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   275.000, DOSAGE=  .23192858-23, CONCENTRATION=  .20262554-24, TIME MEAN ALONGWIND CONCENTRATION=  .38654764-26
                 TIME OF PASSAGE=  .96804918+02, AVERAGE ALONGWIND CONCENTRATION=  .23958347-25
** Y=   280.000, DOSAGE=  .92287003-17, CONCENTRATION=  .80049986-18, TIME MEAN ALONGWIND CONCENTRATION=  .15381167-19
                 TIME OF PASSAGE=  .96833981+02, AVERAGE ALONGWIND CONCENTRATION=  .95304357-19
** Y=   285.000, DOSAGE=  .34851339-12, CONCENTRATION=  .29978854-13, TIME MEAN ALONGWIND CONCENTRATION=  .58085565-15
                 TIME OF PASSAGE=  .96867878+02, AVERAGE ALONGWIND CONCENTRATION=  .35978221-14
** Y=   290.000, DOSAGE=  .74667837-09, CONCENTRATION=  .63638645-10, TIME MEAN ALONGWIND CONCENTRATION=  .12444640-11
                 TIME OF PASSAGE=  .96905548+02, AVERAGE ALONGWIND CONCENTRATION=  .77052180-11
** Y=   295.000, DOSAGE=  .23604635-06, CONCENTRATION=  .19976695-07, TIME MEAN ALONGWIND CONCENTRATION=  .39341058-09
                 TIME OF PASSAGE=  .96945818+02, AVERAGE ALONGWIND CONCENTRATION=  .24348276-08
** Y=   300.000, DOSAGE=  .19943699-04, CONCENTRATION=  .17238264-05, TIME MEAN ALONGWIND CONCENTRATION=  .33239498-07
                 TIME OF PASSAGE=  .96987438+02, AVERAGE ALONGWIND CONCENTRATION=  .20563177-06
** Y=   305.000, DOSAGE=  .69597046-03, CONCENTRATION=  .67405993-04, TIME MEAN ALONGWIND CONCENTRATION=  .11599508-05
                 TIME OF PASSAGE=  .97029120+02, AVERAGE ALONGWIND CONCENTRATION=  .71727998-05
** Y=   310.000, DOSAGE=  .13522702-01, CONCENTRATION=  .15438819-02, TIME MEAN ALONGWIND CONCENTRATION=  .22537836-04
                 TIME OF PASSAGE=  .97069580+02, AVERAGE ALONGWIND CONCENTRATION=  .13930937-03
** Y=   315.000, DOSAGE=  .15856316+00, CONCENTRATION=  .20251419-01, TIME MEAN ALONGWIND CONCENTRATION=  .26427193-03
                 TIME OF PASSAGE=  .97107571+02, AVERAGE ALONGWIND CONCENTRATION=  .16328069-02
** Y=   320.000, DOSAGE=  .11299364+01, CONCENTRATION=  .15203170+00, TIME MEAN ALONGWIND CONCENTRATION=  .18832273-02
                 TIME OF PASSAGE=  .97141927+02, AVERAGE ALONGWIND CONCENTRATION=  .11631610-01
** Y=   325.000, DOSAGE=  .50951268+01, CONCENTRATION=  .69759529+00, TIME MEAN ALONGWIND CONCENTRATION=  .84752113-02
                 TIME OF PASSAGE=  .97171595+02, AVERAGE ALONGWIND CONCENTRATION=  .52331412-01
** Y=   330.000, DOSAGE=  .15283086+02, CONCENTRATION=  .21065123+01, TIME MEAN ALONGWIND CONCENTRATION=  .25471809-01
                 TIME OF PASSAGE=  .97195566+02, AVERAGE ALONGWIND CONCENTRATION=  .15724040+00
** Y=   335.000, DOSAGE=  .32256253+02, CONCENTRATION=  .44439115+01, TIME MEAN ALONGWIND CONCENTRATION=  .53760421-01
                 TIME OF PASSAGE=  .97213405+02, AVERAGE ALONGWIND CONCENTRATION=  .33180669+00
** Y=   340.000, DOSAGE=  .49581349+02, CONCENTRATION=  .68202296+01, TIME MEAN ALONGWIND CONCENTRATION=  .82635566-01
                 TIME OF PASSAGE=  .97224269+02, AVERAGE ALONGWIND CONCENTRATION=  .50993876+00
** Y=   345.000, DOSAGE=  .56701046+02, CONCENTRATION=  .77935343+01, TIME MEAN ALONGWIND CONCENTRATION=  .94501743-01
                 TIME OF PASSAGE=  .97227928+02, AVERAGE ALONGWIND CONCENTRATION=  .58317053+00
** Y=   350.000, DOSAGE=  .48573277+02, CONCENTRATION=  .66797006+01, TIME MEAN ALONGWIND CONCENTRATION=  .80955462-01
                 TIME OF PASSAGE=  .97224270+02, AVERAGE ALONGWIND CONCENTRATION=  .49960053+00
** Y=   355.000, DOSAGE=  .30939567+02, CONCENTRATION=  .42598633+01, TIME MEAN ALONGWIND CONCENTRATION=  .51565945-01
                 TIME OF PASSAGE=  .97213405+02, AVERAGE ALONGWIND CONCENTRATION=  .31826441+00
** Y=      .000, DOSAGE=  .14335651+02, CONCENTRATION=  .19737061+01, TIME MEAN ALONGWIND CONCENTRATION=  .23892751-01
                 TIME OF PASSAGE=  .97195564+02, AVERAGE ALONGWIND CONCENTRATION=  .14749270+00
** Y=     5.000, DOSAGE=  .40567786+01, CONCENTRATION=  .63750000+00, TIME MEAN ALONGWIND CONCENTRATION=  .77612977-02
                 TIME OF PASSAGE=  .97171595+02, AVERAGE ALONGWIND CONCENTRATION=  .47923250-01
** Y=    10.000, DOSAGE=  .10084070+01, CONCENTRATION=  .13521250+00, TIME MEAN ALONGWIND CONCENTRATION=  .16806784-02
                 TIME OF PASSAGE=  .97141927+02, AVERAGE ALONGWIND CONCENTRATION=  .10380760-01
** Y=    15.000, DOSAGE=  .13775837+00, CONCENTRATION=  .17489711-01, TIME MEAN ALONGWIND CONCENTRATION=  .22959728-03
                 TIME OF PASSAGE=  .97107571+02, AVERAGE ALONGWIND CONCENTRATION=  .14186162-02
** Y=    20.000, DOSAGE=  .11446841-01, CONCENTRATION=  .12849125-02, TIME MEAN ALONGWIND CONCENTRATION=  .19078068-04
                 TIME OF PASSAGE=  .97069580+02, AVERAGE ALONGWIND CONCENTRATION=  .11792408-03
** Y=    25.000, DOSAGE=  .57439166-03, CONCENTRATION=  .55150057-04, TIME MEAN ALONGWIND CONCENTRATION=  .95731941-06
                 TIME OF PASSAGE=  .97029119+02, AVERAGE ALONGWIND CONCENTRATION=  .59197863-05
** Y=    30.000, DOSAGE=  .15928748-04, CONCENTRATION=  .13720311-05, TIME MEAN ALONGWIND CONCENTRATION=  .26547913-07
                 TIME OF PASSAGE=  .96987037+02, AVERAGE ALONGWIND CONCENTRATION=  .16423517-06
** Y=    35.000, DOSAGE=  .17975995-06, CONCENTRATION=  .15208165-07, TIME MEAN ALONGWIND CONCENTRATION=  .29959992-09
                 TIME OF PASSAGE=  .96945818+02, AVERAGE ALONGWIND CONCENTRATION=  .18542311-08
** Y=    40.000, DOSAGE=  .53461897-09, CONCENTRATION=  .45564724-10, TIME MEAN ALONGWIND CONCENTRATION=  .89103162-12
                 TIME OF PASSAGE=  .96905548+02, AVERAGE ALONGWIND CONCENTRATION=  .55169978-11
** Y=    45.000, DOSAGE=  .23072028-12, CONCENTRATION=  .19843733-13, TIME MEAN ALONGWIND CONCENTRATION=  .38453380-15
                 TIME OF PASSAGE=  .96867877+02, AVERAGE ALONGWIND CONCENTRATION=  .23818038-14
** Y=    50.000, DOSAGE=  .55220101-17, CONCENTRATION=  .47892679-18, TIME MEAN ALONGWIND CONCENTRATION=  .92033501-20
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                TIME OF PASSAGE=  .96833981+02, AVERAGE ALONGWIND CONCENTRATION=  .57025540-19
** Y=    55.000, DOSAGE=  .12163824-23, CONCENTRATION=  .10626985-24, TIME MEAN ALONGWIND CONCENTRATION=  .20273041-26
                TIME OF PASSAGE=  .96834917+02, AVERAGE ALONGWIND CONCENTRATION=  .12565296-25
** Y=    60.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    65.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=    70.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    75.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=    80.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=    85.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=    90.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=    95.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=   100.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=   105.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   110.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   115.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=   120.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=   125.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   130.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   135.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   140.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=   145.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   150.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   155.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000

                                          * X=    800.00 *
** Y=   255.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   260.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   265.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   270.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   275.000, DOSAGE=  .54208368-25, CONCENTRATION=  .47158781-26, TIME MEAN ALONGWIND CONCENTRATION=  .90347280-28
                TIME OF PASSAGE=  .96821776+02, AVERAGE ALONGWIND CONCENTRATION=  .55987735-27
** Y=   280.000, DOSAGE=  .72340951-18, CONCENTRATION=  .62340301-19, TIME MEAN ALONGWIND CONCENTRATION=  .12056825-20
                TIME OF PASSAGE=  .96859925+02, AVERAGE ALONGWIND CONCENTRATION=  .74686151-20
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** Y=   285.000, DOSAGE=  .66382183-13, CONCENTRATION=  .56590651-14, TIME MEAN ALONGWIND CONCENTRATION=  .11063697-15
             TIME OF PASSAGE=  .96904373+02, AVERAGE ALONGWIND CONCENTRATION=  .68502773-15
** Y=   290.000, DOSAGE=  .27467167-09, CONCENTRATION=  .22351155-10, TIME MEAN ALONGWIND CONCENTRATION=  .45778611-12
             TIME OF PASSAGE=  .96953733+02, AVERAGE ALONGWIND CONCENTRATION=  .28330179-11
** Y=   295.000, DOSAGE=  .13624461-06, CONCENTRATION=  .11136576-07, TIME MEAN ALONGWIND CONCENTRATION=  .22707436-09
             TIME OF PASSAGE=  .97006471+02, AVERAGE ALONGWIND CONCENTRATION=  .14044900-08
** Y=   300.000, DOSAGE=  .15220554-04, CONCENTRATION=  .12559524-05, TIME MEAN ALONGWIND CONCENTRATION=  .25367589-07
             TIME OF PASSAGE=  .97060951+02, AVERAGE ALONGWIND CONCENTRATION=  .15681459-06
** Y=   305.000, DOSAGE=  .61955855-03, CONCENTRATION=  .50733282-04, TIME MEAN ALONGWIND CONCENTRATION=  .10325976-05
             TIME OF PASSAGE=  .97115492+02, AVERAGE ALONGWIND CONCENTRATION=  .63796057-05
** Y=   310.000, DOSAGE=  .12588802-01, CONCENTRATION=  .12517904-02, TIME MEAN ALONGWIND CONCENTRATION=  .20981337-04
             TIME OF PASSAGE=  .97168417+02, AVERAGE ALONGWIND CONCENTRATION=  .12955652-03
** Y=   315.000, DOSAGE=  .14724215+00, CONCENTRATION=  .16174769-01, TIME MEAN ALONGWIND CONCENTRATION=  .24540358-03
             TIME OF PASSAGE=  .97218399+02, AVERAGE ALONGWIND CONCENTRATION=  .15145949-02
** Y=   320.000, DOSAGE=  .10428068+01, CONCENTRATION=  .12117070+00, TIME MEAN ALONGWIND CONCENTRATION=  .17380113-02
             TIME OF PASSAGE=  .97263915+02, AVERAGE ALONGWIND CONCENTRATION=  .10721514-01
** Y=   325.000, DOSAGE=  .46988849+01, CONCENTRATION=  .55887968+00, TIME MEAN ALONGWIND CONCENTRATION=  .78148082-02
             TIME OF PASSAGE=  .97301798+02, AVERAGE ALONGWIND CONCENTRATION=  .48189068-01
** Y=   330.000, DOSAGE=  .14122808+02, CONCENTRATION=  .16093327+01, TIME MEAN ALONGWIND CONCENTRATION=  .23538013-01
             TIME OF PASSAGE=  .97333259+02, AVERAGE ALONGWIND CONCENTRATION=  .14509745+00
** Y=   335.000, DOSAGE=  .29897753+02, CONCENTRATION=  .36261527+01, TIME MEAN ALONGWIND CONCENTRATION=  .49829588-01
             TIME OF PASSAGE=  .97356440+02, AVERAGE ALONGWIND CONCENTRATION=  .30709579+00
** Y=   340.000, DOSAGE=  .46078440+02, CONCENTRATION=  .55577590+01, TIME MEAN ALONGWIND CONCENTRATION=  .76797399-01
             TIME OF PASSAGE=  .97370637+02, AVERAGE ALONGWIND CONCENTRATION=  .47322726+00
** Y=   345.000, DOSAGE=  .52784671+02, CONCENTRATION=  .63646957+01, TIME MEAN ALONGWIND CONCENTRATION=  .87974451-01
             TIME OF PASSAGE=  .97375417+02, AVERAGE ALONGWIND CONCENTRATION=  .54207388+00
** Y=   350.000, DOSAGE=  .45248749+02, CONCENTRATION=  .54560918+01, TIME MEAN ALONGWIND CONCENTRATION=  .75414581-01
             TIME OF PASSAGE=  .97370638+02, AVERAGE ALONGWIND CONCENTRATION=  .46470030+00
** Y=   355.000, DOSAGE=  .28817858+02, CONCENTRATION=  .34736843+01, TIME MEAN ALONGWIND CONCENTRATION=  .48029762-01
             TIME OF PASSAGE=  .97356440+02, AVERAGE ALONGWIND CONCENTRATION=  .29600361+00
** Y=      .000, DOSAGE=  .13346807+02, CONCENTRATION=  .16041304+01, TIME MEAN ALONGWIND CONCENTRATION=  .22244678-01
             TIME OF PASSAGE=  .97333257+02, AVERAGE ALONGWIND CONCENTRATION=  .13712484+00
** Y=     5.000, DOSAGE=  .43384865+01, CONCENTRATION=  .51613129+00, TIME MEAN ALONGWIND CONCENTRATION=  .72308108-02
             TIME OF PASSAGE=  .97301798+02, AVERAGE ALONGWIND CONCENTRATION=  .44567937-01
** Y=    10.000, DOSAGE=  .94331691+00, CONCENTRATION=  .10927045+00, TIME MEAN ALONGWIND CONCENTRATION=  .15721948-02
             TIME OF PASSAGE=  .97263916+02, AVERAGE ALONGWIND CONCENTRATION=  .96986187-02
** Y=    15.000, DOSAGE=  .13004080+00, CONCENTRATION=  .14215947-01, TIME MEAN ALONGWIND CONCENTRATION=  .21673467-03
             TIME OF PASSAGE=  .97218398+02, AVERAGE ALONGWIND CONCENTRATION=  .13376193-02
** Y=    20.000, DOSAGE=  .10846715-01, CONCENTRATION=  .10717095-02, TIME MEAN ALONGWIND CONCENTRATION=  .18077858-04
             TIME OF PASSAGE=  .97168416+02, AVERAGE ALONGWIND CONCENTRATION=  .11162799-03
** Y=    25.000, DOSAGE=  .51957698-03, CONCENTRATION=  .45654790-04, TIME MEAN ALONGWIND CONCENTRATION=  .86596162-06
             TIME OF PASSAGE=  .97115492+02, AVERAGE ALONGWIND CONCENTRATION=  .53500937-05
** Y=    30.000, DOSAGE=  .12330468-04, CONCENTRATION=  .10146156-05, TIME MEAN ALONGWIND CONCENTRATION=  .20550779-07
             TIME OF PASSAGE=  .97060950+02, AVERAGE ALONGWIND CONCENTRATION=  .12703840-06
** Y=    35.000, DOSAGE=  .10535554-06, CONCENTRATION=  .85961643-08, TIME MEAN ALONGWIND CONCENTRATION=  .17559257-09
             TIME OF PASSAGE=  .97006471+02, AVERAGE ALONGWIND CONCENTRATION=  .10860071-08
** Y=    40.000, DOSAGE=  .19942108-09, CONCENTRATION=  .16563769-10, TIME MEAN ALONGWIND CONCENTRATION=  .33236846-12
             TIME OF PASSAGE=  .96953733+02, AVERAGE ALONGWIND CONCENTRATION=  .20568685-11
** Y=    45.000, DOSAGE=  .44262994-13, CONCENTRATION=  .37734094-14, TIME MEAN ALONGWIND CONCENTRATION=  .73771655-16
             TIME OF PASSAGE=  .96904372+02, AVERAGE ALONGWIND CONCENTRATION=  .45676983-15
** Y=    50.000, DOSAGE=  .43356288-18, CONCENTRATION=  .37362572-19, TIME MEAN ALONGWIND CONCENTRATION=  .72260480-21
             TIME OF PASSAGE=  .96859925+02, AVERAGE ALONGWIND CONCENTRATION=  .44761843-20
** Y=    55.000, DOSAGE=  .28147093-25, CONCENTRATION=  .24486673-26, TIME MEAN ALONGWIND CONCENTRATION=  .46911821-28
             TIME OF PASSAGE=  .96821775+02, AVERAGE ALONGWIND CONCENTRATION=  .29071035-27
** Y=    60.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=    65.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   70.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=   75.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=   80.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=   85.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=   95.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=  100.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=  105.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=  110.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=  115.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  120.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  125.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  130.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  135.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  140.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  145.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  150.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  155.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000

                                              * X=    900.00 *
** Y=  255.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  260.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  265.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  270.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=  275.000, DOSAGE=  .69500573-27, CONCENTRATION=  .60180404-28, TIME MEAN ALONGWIND CONCENTRATION=  .11584762-29
                TIME OF PASSAGE=  .96840976+02, AVERAGE ALONGWIND CONCENTRATION=  .71775994-29
** Y=  280.000, DOSAGE=  .43053899-19, CONCENTRATION=  .36835820-20, TIME MEAN ALONGWIND CONCENTRATION=  .71756498-22
                TIME OF PASSAGE=  .96889940+02, AVERAGE ALONGWIND CONCENTRATION=  .44436111-21
** Y=  285.000, DOSAGE=  .13925880-13, CONCENTRATION=  .92227649-15, TIME MEAN ALONGWIND CONCENTRATION=  .18209801-16
                TIME OF PASSAGE=  .96945861+02, AVERAGE ALONGWIND CONCENTRATION=  .11270084-15
** Y=  290.000, DOSAGE=  .14801465-09, CONCENTRATION=  .10352894-10, TIME MEAN ALONGWIND CONCENTRATION=  .24669109-12
                TIME OF PASSAGE=  .97008478+02, AVERAGE ALONGWIND CONCENTRATION=  .15257909-11
** Y=  295.000, DOSAGE=  .89966360-07, CONCENTRATION=  .65644323-08, TIME MEAN ALONGWIND CONCENTRATION=  .14844393-09
                TIME OF PASSAGE=  .97075347+02, AVERAGE ALONGWIND CONCENTRATION=  .91749720-09
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** Y=   300.000, DOSAGE=  .11960204-04, CONCENTRATION=  .91275633-06, TIME MEAN ALONGWIND CONCENTRATION=  .19933673-07
                 TIME OF PASSAGE=  .97144400+02, AVERAGE ALONGWIND CONCENTRATION=  .12311779-06
** Y=   305.000, DOSAGE=  .55131104-03, CONCENTRATION=  .44658750-04, TIME MEAN ALONGWIND CONCENTRATION=  .91885173-06
                 TIME OF PASSAGE=  .97213596+02, AVERAGE ALONGWIND CONCENTRATION=  .56711363-05
** Y=   310.000, DOSAGE=  .11837185-01, CONCENTRATION=  .10520516-02, TIME MEAN ALONGWIND CONCENTRATION=  .19728642-04
                 TIME OF PASSAGE=  .97280542+02, AVERAGE ALONGWIND CONCENTRATION=  .12160091-03
** Y=   315.000, DOSAGE=  .14912340+00, CONCENTRATION=  .13553994-01, TIME MEAN ALONGWIND CONCENTRATION=  .23353900-03
                 TIME OF PASSAGE=  .97343456+02, AVERAGE ALONGWIND CONCENTRATION=  .14394743-02
** Y=   320.000, DOSAGE=  .99145135+00, CONCENTRATION=  .10115681+00, TIME MEAN ALONGWIND CONCENTRATION=  .16524189-02
                 TIME OF PASSAGE=  .97400327+02, AVERAGE ALONGWIND CONCENTRATION=  .10179130-01
** Y=   325.000, DOSAGE=  .44501875+01, CONCENTRATION=  .46651782+00, TIME MEAN ALONGWIND CONCENTRATION=  .74169791-02
                 TIME OF PASSAGE=  .97449415+02, AVERAGE ALONGWIND CONCENTRATION=  .45666041-01
** Y=   330.000, DOSAGE=  .13400351+02, CONCENTRATION=  .14213097+01, TIME MEAN ALONGWIND CONCENTRATION=  .22333918-01
                 TIME OF PASSAGE=  .97489236+02, AVERAGE ALONGWIND CONCENTRATION=  .13745467+00
** Y=   335.000, DOSAGE=  .28387417+02, CONCENTRATION=  .30233456+01, TIME MEAN ALONGWIND CONCENTRATION=  .47312362-01
                 TIME OF PASSAGE=  .97518572+02, AVERAGE ALONGWIND CONCENTRATION=  .29109754+00
** Y=   340.000, DOSAGE=  .43793122+02, CONCENTRATION=  .46687196+01, TIME MEAN ALONGWIND CONCENTRATION=  .72988532-01
                 TIME OF PASSAGE=  .97536537+02, AVERAGE ALONGWIND CONCENTRATION=  .44899195+00
** Y=   345.000, DOSAGE=  .50216791+02, CONCENTRATION=  .53536729+01, TIME MEAN ALONGWIND CONCENTRATION=  .83694651-01
                 TIME OF PASSAGE=  .97542585+02, AVERAGE ALONGWIND CONCENTRATION=  .51481915+00
** Y=   350.000, DOSAGE=  .43086860+02, CONCENTRATION=  .45921257+01, TIME MEAN ALONGWIND CONCENTRATION=  .71811432-01
                 TIME OF PASSAGE=  .97536536+02, AVERAGE ALONGWIND CONCENTRATION=  .44175097+00
** Y=   355.000, DOSAGE=  .27467123+02, CONCENTRATION=  .29235226+01, TIME MEAN ALONGWIND CONCENTRATION=  .45778538-01
                 TIME OF PASSAGE=  .97518572+02, AVERAGE ALONGWIND CONCENTRATION=  .28166643+00
** Y=      .000, DOSAGE=  .12739303+02, CONCENTRATION=  .13497369+01, TIME MEAN ALONGWIND CONCENTRATION=  .21232171-01
                 TIME OF PASSAGE=  .97489237+02, AVERAGE ALONGWIND CONCENTRATION=  .13067394+00
** Y=     5.000, DOSAGE=  .41514428+01, CONCENTRATION=  .43443599+00, TIME MEAN ALONGWIND CONCENTRATION=  .69190713-02
                 TIME OF PASSAGE=  .97449414+02, AVERAGE ALONGWIND CONCENTRATION=  .42601062-01
** Y=    10.000, DOSAGE=  .90631405+00, CONCENTRATION=  .92219874-01, TIME MEAN ALONGWIND CONCENTRATION=  .15105234-02
                 TIME OF PASSAGE=  .97400327+02, AVERAGE ALONGWIND CONCENTRATION=  .93050412-02
** Y=    15.000, DOSAGE=  .12534128+00, CONCENTRATION=  .12074829-01, TIME MEAN ALONGWIND CONCENTRATION=  .20890214-03
                 TIME OF PASSAGE=  .97343457+02, AVERAGE ALONGWIND CONCENTRATION=  .12876190-02
** Y=    20.000, DOSAGE=  .10345958-01, CONCENTRATION=  .91480658-03, TIME MEAN ALONGWIND CONCENTRATION=  .17243264-04
                 TIME OF PASSAGE=  .97280543+02, AVERAGE ALONGWIND CONCENTRATION=  .10635177-03
** Y=    25.000, DOSAGE=  .46966632-03, CONCENTRATION=  .37856069-04, TIME MEAN ALONGWIND CONCENTRATION=  .78277720-06
                 TIME OF PASSAGE=  .97213596+02, AVERAGE ALONGWIND CONCENTRATION=  .48312667-05
** Y=    30.000, DOSAGE=  .98794693-05, CONCENTRATION=  .75036757-06, TIME MEAN ALONGWIND CONCENTRATION=  .16465782-07
                 TIME OF PASSAGE=  .97144398+02, AVERAGE ALONGWIND CONCENTRATION=  .10169081-06
** Y=    35.000, DOSAGE=  .70950001-07, CONCENTRATION=  .51920636-08, TIME MEAN ALONGWIND CONCENTRATION=  .11825000-09
                 TIME OF PASSAGE=  .97075346+02, AVERAGE ALONGWIND CONCENTRATION=  .73587560-09
** Y=    40.000, DOSAGE=  .11361828-09, CONCENTRATION=  .78499996-11, TIME MEAN ALONGWIND CONCENTRATION=  .18936379-12
                 TIME OF PASSAGE=  .97008476+02, AVERAGE ALONGWIND CONCENTRATION=  .11712201-11
** Y=    45.000, DOSAGE=  .73576712-14, CONCENTRATION=  .62107643-15, TIME MEAN ALONGWIND CONCENTRATION=  .12262785-16
                 TIME OF PASSAGE=  .96945363+02, AVERAGE ALONGWIND CONCENTRATION=  .75894640-16
** Y=    50.000, DOSAGE=  .25951187-19, CONCENTRATION=  .22203133-20, TIME MEAN ALONGWIND CONCENTRATION=  .43251978-22
                 TIME OF PASSAGE=  .96889449+02, AVERAGE ALONGWIND CONCENTRATION=  .26784330-21
** Y=    55.000, DOSAGE=  .35988794-27, CONCENTRATION=  .31159040-28, TIME MEAN ALONGWIND CONCENTRATION=  .59981323-30
                 TIME OF PASSAGE=  .96843975+02, AVERAGE ALONGWIND CONCENTRATION=  .37162775-29
** Y=    60.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    65.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    70.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    75.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    80.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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** Y=    90.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=    95.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   100.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   105.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   110.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   115.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   120.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   125.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   130.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   135.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   140.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   145.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   150.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   155.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
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                                       ***** LAYER 2 *****

                                        ** INPUT DATA **

 Q=  .34900000+06, UBAR AT BOTTOM=  8.9000, UBAR AT TOP=  9.6000, SIGAK AT BOTTOM= 5.41000, SIGAK AT TOP= 5.05000
SIGEK AT BOTTOM= 5.13000, SIGEK AT TOP= 4.79000, SIGXO=  44.6500, SIGYO=  44.6500, SIGZO=  28.8700, THETAK AT BOTTOM=150.0000
THETAK AT TOP=150.0000, Z=  100.000, ALPHA=1.00, BETA=1.00, H=     .000, DELX=  .00000000   , DELY=  .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =    9.25000, THETA = 150.00000, DELTHP =    .00000, DELU =    .70000
, SIGAP =    .08659, SIGEP =    .08657
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                                       ***** LAYER 3 *****

                                        ** INPUT DATA **

 Q=  .96600000+06, UBAR AT BOTTOM=  9.6000, UBAR AT TOP=  9.9000, SIGAK AT BOTTOM= 5.05000, SIGAK AT TOP= 4.85000
SIGEK AT BOTTOM= 4.79000, SIGEK AT TOP= 4.60000, SIGXO=  74.4200, SIGYO=  74.4200, SIGZO=  28.8700, THETAK AT BOTTOM=150.0000
THETAK AT TOP=152.0000, Z=  200.000, ALPHA=1.00, BETA=1.00, H=     .000, DELX=  .00000000   , DELY=  .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =    9.75000, THETA = 151.00000, DELTHP =   2.00000, DELU =    .30000
, SIGAP =    .08196, SIGEP =    .08194
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                                    ***** LAYER 4 *****

                                    ** INPUT DATA **

 Q=  .22700000+07, UBAR AT BOTTOM=  9.9000, UBAR AT TOP= 10.2000, SIGAK AT BOTTOM= 4.85000, SIGAK AT TOP= 4.71000
SIGEK AT BOTTOM= 4.60000, SIGEK AT TOP= 4.47000, SIGXO= 104.1900, SIGYO= 104.1900, SIGZO=  28.8700, THETAK AT BOTTOM=152.0000
THETAK AT TOP=153.0000, Z=  300.000, ALPHA=1.00, BETA=1.00, H=      .000, DELX=  .00000000   , DELY=  .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =  10.05000, THETA = 152.50000, DELTHP =   1.00000, DELU =    .30000
, SIGAP =    .07914, SIGEP =    .07915
           ------------------------------------------------------------------------------------------------------

                                    ***** LAYER 5 *****

                                    ** INPUT DATA **

 Q=  .45500000+07, UBAR AT BOTTOM= 10.2000, UBAR AT TOP= 10.4000, SIGAK AT BOTTOM= 4.71000, SIGAK AT TOP= 4.61000
SIGEK AT BOTTOM= 4.47000, SIGEK AT TOP= 4.37000, SIGXO= 133.9500, SIGYO= 133.9500, SIGZO=  28.8700, THETAK AT BOTTOM=153.0000
THETAK AT TOP=157.0000, Z=  400.000, ALPHA=1.00, BETA=1.00, H=      .000, DELX=  .00000000   , DELY=  .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =  10.30000, THETA = 155.00000, DELTHP =   4.00000, DELU =    .20000
, SIGAP =    .07716, SIGEP =    .07714
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                                    ***** LAYER 6 *****

                                    ** INPUT DATA **

 Q=  .77700000+07, UBAR AT BOTTOM= 10.4000, UBAR AT TOP= 10.6000, SIGAK AT BOTTOM= 4.61000, SIGAK AT TOP= 4.52000
SIGEK AT BOTTOM= 4.37000, SIGEK AT TOP= 4.29000, SIGXO= 163.7200, SIGYO= 163.7200, SIGZO=  28.8700, THETAK AT BOTTOM=157.0000
THETAK AT TOP=160.0000, Z=  500.000, ALPHA=1.00, BETA=1.00, H=      .000, DELX=  .00000000   , DELY=  .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =  10.50000, THETA = 158.50000, DELTHP =   3.00000, DELU =    .20000
, SIGAP =    .07558, SIGEP =    .07557
           ------------------------------------------------------------------------------------------------------

                                    ***** LAYER 7 *****

                                    ** INPUT DATA **

 Q=  .11300000+08, UBAR AT BOTTOM= 10.6000, UBAR AT TOP= 10.8000, SIGAK AT BOTTOM= 4.52000, SIGAK AT TOP= 4.45000
SIGEK AT BOTTOM= 4.29000, SIGEK AT TOP= 4.23000, SIGXO= 193.4900, SIGYO= 193.4900, SIGZO=  28.8700, THETAK AT BOTTOM=160.0000
THETAK AT TOP=170.0000, Z=  600.000, ALPHA=1.00, BETA=1.00, H=      .000, DELX=  .00000000   , DELY=  .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =  10.70000, THETA = 165.00000, DELTHP =  10.00000, DELU =    .20000
, SIGAP =    .07426, SIGEP =    .07435
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                                        ***** LAYER 8 *****

                                         ** INPUT DATA **

 Q=  .13900000+08, UBAR AT BOTTOM= 10.8000, UBAR AT TOP= 10.9000, SIGAK AT BOTTOM= 4.45000, SIGAK AT TOP= 4.39000
SIGEK AT BOTTOM= 4.23000, SIGEK AT TOP= 4.17000, SIGXO= 223.2600, SIGYO= 223.2600, SIGZO=  28.8700, THETAK AT BOTTOM=170.0000
THETAK AT TOP=180.0000, Z=  700.000, ALPHA=1.00, BETA=1.00, H=      .000, DELX=  .00000000    , DELY=  .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =  10.85000, THETA = 175.00000, DELTHP =  10.00000, DELU =    .10000
, SIGAP =     .07318, SIGEP =     .07330
              ------------------------------------------------------------------------------------------------


                                        ***** LAYER 9 *****

                                         ** INPUT DATA **

 Q=  .96100000+07, UBAR AT BOTTOM= 10.9000, UBAR AT TOP= 10.0000, SIGAK AT BOTTOM= 4.39000, SIGAK AT TOP= 2.00000
SIGEK AT BOTTOM= 4.17000, SIGEK AT TOP= 1.90000, SIGXO= 182.7700, SIGYO= 182.7700, SIGZO= 144.3400, THETAK AT BOTTOM=180.0000
THETAK AT TOP=228.0000, Z=  800.000, ALPHA=1.00, BETA=1.00, H=      .000, DELX=  .00000000    , DELY=  .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =  10.45000, THETA = 204.00000, DELTHP =  48.00000, DELU =   -.90000
, SIGAP =     .05290, SIGEP =     .05297
              ------------------------------------------------------------------------------------------------


         ** CALCULATION HEIGHT Z=  800.000, CLOUD AXIS IS AT  24.000 DEGREES AZIMUTH BEARING RELATIVE TO ORIGIN

                                              * X=     500.00 *
** Y=    24.000, DOSAGE=  .15896679+04, CONCENTRATION=  .36260902+02, TIME MEAN ALONGWIND CONCENTRATION=  .26494464+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .21137290+02
** Y=   255.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   260.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   265.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   270.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   275.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   280.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   285.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   290.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   295.000, DOSAGE=  .48438527+02, CONCENTRATION=  .11048730+01, TIME MEAN ALONGWIND CONCENTRATION=  .80730877-01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .64407115+00
** Y=   300.000, DOSAGE=  .54993343+02, CONCENTRATION=  .12543870+01, TIME MEAN ALONGWIND CONCENTRATION=  .91655571-01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .73122838+00
** Y=   305.000, DOSAGE=  .66088734+02, CONCENTRATION=  .15074706+01, TIME MEAN ALONGWIND CONCENTRATION=  .11014789+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .87676014+00
** Y=   310.000, DOSAGE=  .83148583+02, CONCENTRATION=  .18966024+01, TIME MEAN ALONGWIND CONCENTRATION=  .13858097+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .11055993+01
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** Y=   315.000, DOSAGE=  .13821695+03, CONCENTRATION=  .24634066+01, TIME MEAN ALONGWIND CONCENTRATION=  .18036159+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .14389252+01
** Y=   320.000, DOSAGE=  .14396603+03, CONCENTRATION=  .32839360+01, TIME MEAN ALONGWIND CONCENTRATION=  .23994338+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .19142689+01
** Y=   325.000, DOSAGE=  .19359303+03, CONCENTRATION=  .44158178+01, TIME MEAN ALONGWIND CONCENTRATION=  .32265504+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .25741428+01
** Y=   330.000, DOSAGE=  .26053380+03, CONCENTRATION=  .59427233+01, TIME MEAN ALONGWIND CONCENTRATION=  .43422300+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .34642322+01
** Y=   335.000, DOSAGE=  .34794229+03, CONCENTRATION=  .79364933+01, TIME MEAN ALONGWIND CONCENTRATION=  .57990382+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .46264741+01
** Y=   340.000, DOSAGE=  .45794101+03, CONCENTRATION=  .10445542+02, TIME MEAN ALONGWIND CONCENTRATION=  .76323502+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .60890909+01
** Y=   345.000, DOSAGE=  .59073256+03, CONCENTRATION=  .13474490+02, TIME MEAN ALONGWIND CONCENTRATION=  .98455426+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .78547764+01
** Y=   350.000, DOSAGE=  .74375325+03, CONCENTRATION=  .16964861+02, TIME MEAN ALONGWIND CONCENTRATION=  .12395887+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .98894422+01
** Y=   355.000, DOSAGE=  .91110912+03, CONCENTRATION=  .20782214+02, TIME MEAN ALONGWIND CONCENTRATION=  .15185152+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .12114718+02
** Y=      .000, DOSAGE=  .10835335+04, CONCENTRATION=  .24715179+02, TIME MEAN ALONGWIND CONCENTRATION=  .18058891+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .14407383+02
** Y=     5.000, DOSAGE=  .12490057+04, CONCENTRATION=  .28490556+02, TIME MEAN ALONGWIND CONCENTRATION=  .20816762+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .16607618+02
** Y=    10.000, DOSAGE=  .13940577+04, CONCENTRATION=  .31798174+02, TIME MEAN ALONGWIND CONCENTRATION=  .23234294+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .18535326+02
** Y=    15.000, DOSAGE=  .15055577+04, CONCENTRATION=  .34341466+02, TIME MEAN ALONGWIND CONCENTRATION=  .25092628+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .20018965+02
** Y=    20.000, DOSAGE=  .15726723+04, CONCENTRATION=  .35872349+02, TIME MEAN ALONGWIND CONCENTRATION=  .26211214+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .20911313+02
** Y=    25.000, DOSAGE=  .15886001+04, CONCENTRATION=  .36235603+02, TIME MEAN ALONGWIND CONCENTRATION=  .26476668+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .21123092+02
** Y=    30.000, DOSAGE=  .15516954+04, CONCENTRATION=  .35393857+02, TIME MEAN ALONGWIND CONCENTRATION=  .25861589+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .20632382+02
** Y=    35.000, DOSAGE=  .14657509+04, CONCENTRATION=  .33433482+02, TIME MEAN ALONGWIND CONCENTRATION=  .24429182+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .19489667+02
** Y=    40.000, DOSAGE=  .13393583+04, CONCENTRATION=  .30550492+02, TIME MEAN ALONGWIND CONCENTRATION=  .22322639+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .17809007+02
** Y=    45.000, DOSAGE=  .11844996+04, CONCENTRATION=  .27018197+02, TIME MEAN ALONGWIND CONCENTRATION=  .19741661+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .15749902+02
** Y=    50.000, DOSAGE=  .10146761+04, CONCENTRATION=  .23144557+02, TIME MEAN ALONGWIND CONCENTRATION=  .16911269+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .13491615+02
** Y=    55.000, DOSAGE=  .84296973+03, CONCENTRATION=  .19227959+02, TIME MEAN ALONGWIND CONCENTRATION=  .14049495+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .11208691+02
** Y=    60.000, DOSAGE=  .68041818+03, CONCENTRATION=  .15520201+02, TIME MEAN ALONGWIND CONCENTRATION=  .11340303+01
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .90472906+01
** Y=    65.000, DOSAGE=  .53497579+03, CONCENTRATION=  .12202390+02, TIME MEAN ALONGWIND CONCENTRATION=  .89162631+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .71133970+01
** Y=    70.000, DOSAGE=  .41116528+03, CONCENTRATION=  .93785968+01, TIME MEAN ALONGWIND CONCENTRATION=  .68527547+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .54671294+01
** Y=    75.000, DOSAGE=  .31035467+03, CONCENTRATION=  .70791271+01, TIME MEAN ALONGWIND CONCENTRATION=  .51725777+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .41266838+01
** Y=    80.000, DOSAGE=  .23146459+03, CONCENTRATION=  .52796673+01, TIME MEAN ALONGWIND CONCENTRATION=  .38577431+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .30777284+01
** Y=    85.000, DOSAGE=  .17185793+03, CONCENTRATION=  .39200447+01, TIME MEAN ALONGWIND CONCENTRATION=  .28642989+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .22851384+01
** Y=    90.000, DOSAGE=  .12818989+03, CONCENTRATION=  .29239855+01, TIME MEAN ALONGWIND CONCENTRATION=  .21364981+00
              TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .17044980+01
** Y=    95.000, DOSAGE=  .97071397+02, CONCENTRATION=  .22141789+01, TIME MEAN ALONGWIND CONCENTRATION=  .16178566+00
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                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .12907264+01
** Y=   100.000, DOSAGE=  .75492598+02, CONCENTRATION=  .17219709+01, TIME MEAN ALONGWIND CONCENTRATION=  .12582099+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .10038302+01
** Y=   105.000, DOSAGE=  .61028095+02, CONCENTRATION=  .13920385+01, TIME MEAN ALONGWIND CONCENTRATION=  .10171349+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .81147049+00
** Y=   110.000, DOSAGE=  .51886647+02, CONCENTRATION=  .11835239+01, TIME MEAN ALONGWIND CONCENTRATION=  .86477745-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .68991967+00
** Y=   115.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   120.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   125.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   130.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   135.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   140.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   145.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   150.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   155.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000

                                              * X=    600.00 *
** Y=    24.000, DOSAGE=  .15017753+04, CONCENTRATION=  .34255191+02, TIME MEAN ALONGWIND CONCENTRATION=  .25029588+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .19968612+02
** Y=   255.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   260.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   265.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   270.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   275.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   280.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   285.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   290.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   295.000, DOSAGE=  .94671698+01, CONCENTRATION=  .21594423+00, TIME MEAN ALONGWIND CONCENTRATION=  .15778616-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .12588184+00
** Y=   300.000, DOSAGE=  .11766552+02, CONCENTRATION=  .26839267+00, TIME MEAN ALONGWIND CONCENTRATION=  .19610920-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .15645597+00
** Y=   305.000, DOSAGE=  .15917676+02, CONCENTRATION=  .36307896+00, TIME MEAN ALONGWIND CONCENTRATION=  .26529460-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .21165210+00
** Y=   310.000, DOSAGE=  .22968110+02, CONCENTRATION=  .52389794+00, TIME MEAN ALONGWIND CONCENTRATION=  .38280183-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .30539940+00
** Y=   315.000, DOSAGE=  .34617626+02, CONCENTRATION=  .78962105+00, TIME MEAN ALONGWIND CONCENTRATION=  .57696044-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .46029918+00
** Y=   320.000, DOSAGE=  .53432562+02, CONCENTRATION=  .12187859+01, TIME MEAN ALONGWIND CONCENTRATION=  .89054270-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .71047519+00
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** Y=   325.000, DOSAGE=  .83002060+02, CONCENTRATION=  .10932602+01, TIME MEAN ALONGWIND CONCENTRATION=  .13833677+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .11036911+01
** Y=   330.000, DOSAGE=  .12790011+03, CONCENTRATION=  .29173757+01, TIME MEAN ALONGWIND CONCENTRATION=  .21316685+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .17060457+01
** Y=   335.000, DOSAGE=  .19329125+03, CONCENTRATION=  .44089342+01, TIME MEAN ALONGWIND CONCENTRATION=  .32215207+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .25701301+01
** Y=   340.000, DOSAGE=  .28405963+03, CONCENTRATION=  .64793428+01, TIME MEAN ALONGWIND CONCENTRATION=  .47343272+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .37770474+01
** Y=   345.000, DOSAGE=  .40347860+03, CONCENTRATION=  .92032652+01, TIME MEAN ALONGWIND CONCENTRATION=  .67246433+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .53649221+01
** Y=   350.000, DOSAGE=  .55164234+03, CONCENTRATION=  .12583850+02, TIME MEAN ALONGWIND CONCENTRATION=  .91940390+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .73350667+01
** Y=   355.000, DOSAGE=  .72407890+03, CONCENTRATION=  .16516093+02, TIME MEAN ALONGWIND CONCENTRATION=  .12067982+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .96278387+01
** Y=      .000, DOSAGE=  .91105405+03, CONCENTRATION=  .20780959+02, TIME MEAN ALONGWIND CONCENTRATION=  .15184234+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .12113986+02
** Y=     5.000, DOSAGE=  .10979698+04, CONCENTRATION=  .25044468+02, TIME MEAN ALONGWIND CONCENTRATION=  .18299496+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .14599343+02
** Y=    10.000, DOSAGE=  .12670336+04, CONCENTRATION=  .28900780+02, TIME MEAN ALONGWIND CONCENTRATION=  .21117226+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .16847328+02
** Y=    15.000, DOSAGE=  .13999480+04, CONCENTRATION=  .31932530+02, TIME MEAN ALONGWIND CONCENTRATION=  .23332466+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .18614647+02
** Y=    20.000, DOSAGE=  .14810965+04, CONCENTRATION=  .33787512+02, TIME MEAN ALONGWIND CONCENTRATION=  .24684942+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .19695653+02
** Y=    25.000, DOSAGE=  .15004746+04, CONCENTRATION=  .34225521+02, TIME MEAN ALONGWIND CONCENTRATION=  .25007909+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .19951916+02
** Y=    30.000, DOSAGE=  .14556439+04, CONCENTRATION=  .33200942+02, TIME MEAN ALONGWIND CONCENTRATION=  .24260731+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .19355217+02
** Y=    35.000, DOSAGE=  .13522169+04, CONCENTRATION=  .30843793+02, TIME MEAN ALONGWIND CONCENTRATION=  .22536947+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .17979982+02
** Y=    40.000, DOSAGE=  .12027466+04, CONCENTRATION=  .27434405+02, TIME MEAN ALONGWIND CONCENTRATION=  .20045776+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .15992523+02
** Y=    45.000, DOSAGE=  .10243051+04, CONCENTRATION=  .23360193+02, TIME MEAN ALONGWIND CONCENTRATION=  .17071752+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .13619848+02
** Y=    50.000, DOSAGE=  .83535912+03, CONCENTRATION=  .19054372+02, TIME MEAN ALONGWIND CONCENTRATION=  .13922652+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .11107895+02
** Y=    55.000, DOSAGE=  .65269730+03, CONCENTRATION=  .14887893+02, TIME MEAN ALONGWIND CONCENTRATION=  .10878288+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .86787610+01
** Y=    60.000, DOSAGE=  .48910035+03, CONCENTRATION=  .11156280+02, TIME MEAN ALONGWIND CONCENTRATION=  .81516725+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .65034364+01
** Y=    65.000, DOSAGE=  .35217875+03, CONCENTRATION=  .80331250+01, TIME MEAN ALONGWIND CONCENTRATION=  .58696458+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .46828049+01
** Y=    70.000, DOSAGE=  .24444438+03, CONCENTRATION=  .55757269+01, TIME MEAN ALONGWIND CONCENTRATION=  .40740730+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .32502965+01
** Y=    75.000, DOSAGE=  .16434377+03, CONCENTRATION=  .37486480+01, TIME MEAN ALONGWIND CONCENTRATION=  .27390627+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .21852250+01
** Y=    80.000, DOSAGE=  .10777685+03, CONCENTRATION=  .24583682+01, TIME MEAN ALONGWIND CONCENTRATION=  .17962809+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .14330733+01
** Y=    85.000, DOSAGE=  .69610790+02, CONCENTRATION=  .15877080+01, TIME MEAN ALONGWIND CONCENTRATION=  .11601798+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .92559177+00
** Y=    90.000, DOSAGE=  .44840988+02, CONCENTRATION=  .10228139+01, TIME MEAN ALONGWIND CONCENTRATION=  .74734979-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .59623586+00
** Y=    95.000, DOSAGE=  .29263579+02, CONCENTRATION=  .66749632+00, TIME MEAN ALONGWIND CONCENTRATION=  .48772632-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .38910818+00
** Y=   100.000, DOSAGE=  .19708438+02, CONCENTRATION=  .44954549+00, TIME MEAN ALONGWIND CONCENTRATION=  .32847397-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .26205662+00
** Y=   105.000, DOSAGE=  .13980350+02, CONCENTRATION=  .31888894+00, TIME MEAN ALONGWIND CONCENTRATION=  .23300583-01
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                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .18589211+00
** Y=   110.000, DOSAGE=  .10666028+02, CONCENTRATION=  .24328995+00, TIME MEAN ALONGWIND CONCENTRATION=  .17776714-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .14182267+00
** Y=   115.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   120.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   125.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   130.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   135.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   140.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   145.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   150.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   155.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000

                                        * X=    700.00 *
** Y=    24.000, DOSAGE=  .14182966+04, CONCENTRATION=  .32351058+02, TIME MEAN ALONGWIND CONCENTRATION=  .23638276+01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .18658623+02
** Y=   255.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   260.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   265.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   270.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   275.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   280.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   285.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   290.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   295.000, DOSAGE=  .13794818+01, CONCENTRATION=  .31465791-01, TIME MEAN ALONGWIND CONCENTRATION=  .22991364-02
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .18342516-01
** Y=   300.000, DOSAGE=  .19438381+01, CONCENTRATION=  .44339554-01, TIME MEAN ALONGWIND CONCENTRATION=  .32397302-02
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .25846576-01
** Y=   305.000, DOSAGE=  .30869708+01, CONCENTRATION=  .70413179-01, TIME MEAN ALONGWIND CONCENTRATION=  .51449513-02
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .41046435-01
** Y=   310.000, DOSAGE=  .53373423+01, CONCENTRATION=  .12174370+00, TIME MEAN ALONGWIND CONCENTRATION=  .88955704-02
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .70968863-01
** Y=   315.000, DOSAGE=  .97106438+01, CONCENTRATION=  .22149792+00, TIME MEAN ALONGWIND CONCENTRATION=  .16184406-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .12911923+00
** Y=   320.000, DOSAGE=  .18034604+02, CONCENTRATION=  .41136567+00, TIME MEAN ALONGWIND CONCENTRATION=  .30057673-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .23980019+00
** Y=   325.000, DOSAGE=  .33345470+02, CONCENTRATION=  .76060394+00, TIME MEAN ALONGWIND CONCENTRATION=  .55575784-01
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .44338375+00
** Y=   330.000, DOSAGE=  .60214558+02, CONCENTRATION=  .13734819+01, TIME MEAN ALONGWIND CONCENTRATION=  .10035760+00
                TIME OF PASSAGE=  .75206795+02, AVERAGE ALONGWIND CONCENTRATION=  .80065315+00
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             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   145.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   150.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   155.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
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                                   ***** LAYER10 *****

                                    ** INPUT DATA **

 Q=  .54000000+06, UBAR AT BOTTOM= 10.0000, UBAR AT TOP= 11.9000, SIGAK AT BOTTOM= 2.00000, SIGAK AT TOP= 1.00000
SIGEK AT BOTTOM= 1.90000, SIGEK AT TOP=  .95000, SIGXO=  93.0000, SIGYO=  93.0000, SIGZO= 144.3400, THETAK AT BOTTOM=228.0000
THETAK AT TOP=240.0000, Z= 1300.000, ALPHA=1.00, BETA=1.00, H=     .000, DELX=  .00000000   , DELY=  .00000000
IZMOD=1

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =  10.95000, THETA = 234.00000, DELTHP =  12.00000, DELU =   1.90000
, SIGAP =    .02484, SIGEP =    .02487
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     ** CALCULATION HEIGHT Z= 1300.000, CLOUD AXIS IS AT  54.000 DEGREES AZIMUTH BEARING RELATIVE TO ORIGIN

                                        * X=    500.00 *
** Y=    54.000, DOSAGE=  .18183815+03, CONCENTRATION=  .85256287+01, TIME MEAN ALONGWIND CONCENTRATION=  .30306358+00
             TIME OF PASSAGE=  .36587867+02, AVERAGE ALONGWIND CONCENTRATION=  .49699029+01
** Y=   255.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   260.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   265.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   270.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   275.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   280.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   285.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   290.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   295.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   300.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   305.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   310.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   315.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   320.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
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** Y=   325.000, DOSAGE=  .11092693-03, CONCENTRATION=  .56332328-05, TIME MEAN ALONGWIND CONCENTRATION=  .19987821-06
               TIME OF PASSAGE=  .36522568+02, AVERAGE ALONGWIND CONCENTRATION=  .32838188-05
** Y=   330.000, DOSAGE=  .19287695-03, CONCENTRATION=  .96596786-05, TIME MEAN ALONGWIND CONCENTRATION=  .32146157-06
               TIME OF PASSAGE=  .36521284+02, AVERAGE ALONGWIND CONCENTRATION=  .52812263-05
** Y=   335.000, DOSAGE=  .37691724-03, CONCENTRATION=  .17703456-04, TIME MEAN ALONGWIND CONCENTRATION=  .62819539-06
               TIME OF PASSAGE=  .36523001+02, AVERAGE ALONGWIND CONCENTRATION=  .10319996-04
** Y=   340.000, DOSAGE=  .86966611-03, CONCENTRATION=  .40844436-04, TIME MEAN ALONGWIND CONCENTRATION=  .14494435-05
               TIME OF PASSAGE=  .36525666+02, AVERAGE ALONGWIND CONCENTRATION=  .23809726-04
** Y=   345.000, DOSAGE=  .22044667-02, CONCENTRATION=  .10775090-03, TIME MEAN ALONGWIND CONCENTRATION=  .38241145-05
               TIME OF PASSAGE=  .36529200+02, AVERAGE ALONGWIND CONCENTRATION=  .62811907-04
** Y=   350.000, DOSAGE=  .66918199-02, CONCENTRATION=  .31421835-03, TIME MEAN ALONGWIND CONCENTRATION=  .11153033-04
               TIME OF PASSAGE=  .36533494+02, AVERAGE ALONGWIND CONCENTRATION=  .18316945-03
** Y=   355.000, DOSAGE=  .20948615-01, CONCENTRATION=  .97882711-03, TIME MEAN ALONGWIND CONCENTRATION=  .34747691-04
               TIME OF PASSAGE=  .36538417+02, AVERAGE ALONGWIND CONCENTRATION=  .57059435-03
** Y=      .000, DOSAGE=  .67105773-01, CONCENTRATION=  .31501028-02, TIME MEAN ALONGWIND CONCENTRATION=  .11184295-03
               TIME OF PASSAGE=  .36543820+02, AVERAGE ALONGWIND CONCENTRATION=  .18363097-02
** Y=     5.000, DOSAGE=  .21616429+00, CONCENTRATION=  .10145666-01, TIME MEAN ALONGWIND CONCENTRATION=  .36027381-03
               TIME OF PASSAGE=  .36549538+02, AVERAGE ALONGWIND CONCENTRATION=  .59142822-02
** Y=    10.000, DOSAGE=  .67666377+00, CONCENTRATION=  .31754109-01, TIME MEAN ALONGWIND CONCENTRATION=  .11277729-02
               TIME OF PASSAGE=  .36555398+02, AVERAGE ALONGWIND CONCENTRATION=  .18510639-01
** Y=    15.000, DOSAGE=  .20042411+01, CONCENTRATION=  .94039952-01, TIME MEAN ALONGWIND CONCENTRATION=  .33404018-02
               TIME OF PASSAGE=  .36561221+02, AVERAGE ALONGWIND CONCENTRATION=  .54818768-01
** Y=    20.000, DOSAGE=  .54859602+01, CONCENTRATION=  .25736166+00, TIME MEAN ALONGWIND CONCENTRATION=  .91432669-02
               TIME OF PASSAGE=  .36566830+02, AVERAGE ALONGWIND CONCENTRATION=  .15002559+00
** Y=    25.000, DOSAGE=  .13594901+02, CONCENTRATION=  .63768352+00, TIME MEAN ALONGWIND CONCENTRATION=  .22658168-01
               TIME OF PASSAGE=  .36572055+02, AVERAGE ALONGWIND CONCENTRATION=  .37172920+00
** Y=    30.000, DOSAGE=  .29975765+02, CONCENTRATION=  .14058656+01, TIME MEAN ALONGWIND CONCENTRATION=  .49959608-01
               TIME OF PASSAGE=  .36576738+02, AVERAGE ALONGWIND CONCENTRATION=  .81953384+00
** Y=    35.000, DOSAGE=  .57970578+02, CONCENTRATION=  .27185272+01, TIME MEAN ALONGWIND CONCENTRATION=  .96617629-01
               TIME OF PASSAGE=  .36580738+02, AVERAGE ALONGWIND CONCENTRATION=  .15847296+01
** Y=    40.000, DOSAGE=  .97214980+02, CONCENTRATION=  .45584934+01, TIME MEAN ALONGWIND CONCENTRATION=  .16202497+00
               TIME OF PASSAGE=  .36583932+02, AVERAGE ALONGWIND CONCENTRATION=  .26573137+01
** Y=    45.000, DOSAGE=  .14015569+03, CONCENTRATION=  .65716088+01, TIME MEAN ALONGWIND CONCENTRATION=  .23359282+00
               TIME OF PASSAGE=  .36586221+02, AVERAGE ALONGWIND CONCENTRATION=  .38308327+01
** Y=    50.000, DOSAGE=  .17260233+03, CONCENTRATION=  .80969921+01, TIME MEAN ALONGWIND CONCENTRATION=  .28782055+00
               TIME OF PASSAGE=  .36587540+02, AVERAGE ALONGWIND CONCENTRATION=  .47199766+01
** Y=    55.000, DOSAGE=  .18125214+03, CONCENTRATION=  .84981582+01, TIME MEAN ALONGWIND CONCENTRATION=  .30208690+00
               TIME OF PASSAGE=  .36587847+02, AVERAGE ALONGWIND CONCENTRATION=  .49538093+01
** Y=    60.000, DOSAGE=  .16192388+03, CONCENTRATION=  .75920895+01, TIME MEAN ALONGWIND CONCENTRATION=  .26987312+00
               TIME OF PASSAGE=  .36587132+02, AVERAGE ALONGWIND CONCENTRATION=  .44257056+01
** Y=    65.000, DOSAGE=  .12334668+03, CONCENTRATION=  .57535950+01, TIME MEAN ALONGWIND CONCENTRATION=  .20557780+00
               TIME OF PASSAGE=  .36585818+02, AVERAGE ALONGWIND CONCENTRATION=  .33714710+01
** Y=    70.000, DOSAGE=  .80467073+02, CONCENTRATION=  .37732929+01, TIME MEAN ALONGWIND CONCENTRATION=  .13411179+00
               TIME OF PASSAGE=  .36582757+02, AVERAGE ALONGWIND CONCENTRATION=  .21995902+01
** Y=    75.000, DOSAGE=  .45270206+02, CONCENTRATION=  .21230315+01, TIME MEAN ALONGWIND CONCENTRATION=  .75450343-01
               TIME OF PASSAGE=  .36579228+02, AVERAGE ALONGWIND CONCENTRATION=  .12375932+01
** Y=    80.000, DOSAGE=  .22178274+02, CONCENTRATION=  .10400138+01, TIME MEAN ALONGWIND CONCENTRATION=  .36963790-01
               TIME OF PASSAGE=  .36574940+02, AVERAGE ALONGWIND CONCENTRATION=  .60637095+00
** Y=    85.000, DOSAGE=  .95812352+01, CONCENTRATION=  .44944310+00, TIME MEAN ALONGWIND CONCENTRATION=  .15968725-01
               TIME OF PASSAGE=  .36570022+02, AVERAGE ALONGWIND CONCENTRATION=  .26199698+00
** Y=    90.000, DOSAGE=  .37071915+01, CONCENTRATION=  .17392517+00, TIME MEAN ALONGWIND CONCENTRATION=  .61786524-02
               TIME OF PASSAGE=  .36564623+02, AVERAGE ALONGWIND CONCENTRATION=  .10138738+00
** Y=    95.000, DOSAGE=  .13088431+01, CONCENTRATION=  .61414777-01, TIME MEAN ALONGWIND CONCENTRATION=  .21814051-02
               TIME OF PASSAGE=  .36558907+02, AVERAGE ALONGWIND CONCENTRATION=  .35800935-01
** Y=   100.000, DOSAGE=  .43092246+00, CONCENTRATION=  .20223394-01, TIME MEAN ALONGWIND CONCENTRATION=  .71820410-03
               TIME OF PASSAGE=  .36553048+02, AVERAGE ALONGWIND CONCENTRATION=  .11788961-01
** Y=   105.000, DOSAGE=  .13563636+00, CONCENTRATION=  .63664925-02, TIME MEAN ALONGWIND CONCENTRATION=  .22606059-03
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              TIME OF PASSAGE=  .36547224+02, AVERAGE ALONGWIND CONCENTRATION=  .37112629-02
** Y=   110.000, DOSAGE=  .41965724-01, CONCENTRATION=  .19700876-02, TIME MEAN ALONGWIND CONCENTRATION=  .69942872-04
              TIME OF PASSAGE=  .36541612+02, AVERAGE ALONGWIND CONCENTRATION=  .11484366-02
** Y=   115.000, DOSAGE=  .13157422-01, CONCENTRATION=  .61776569-03, TIME MEAN ALONGWIND CONCENTRATION=  .21929037-04
              TIME OF PASSAGE=  .36536382+02, AVERAGE ALONGWIND CONCENTRATION=  .30011837-03
** Y=   120.000, DOSAGE=  .43185110-02, CONCENTRATION=  .20278823-03, TIME MEAN ALONGWIND CONCENTRATION=  .71975183-05
              TIME OF PASSAGE=  .36531693+02, AVERAGE ALONGWIND CONCENTRATION=  .11821273-03
** Y=   125.000, DOSAGE=  .15349644-02, CONCENTRATION=  .72286614-04, TIME MEAN ALONGWIND CONCENTRATION=  .25582740-05
              TIME OF PASSAGE=  .36527689+02, AVERAGE ALONGWIND CONCENTRATION=  .42021941-04
** Y=   130.000, DOSAGE=  .61139683-03, CONCENTRATION=  .28715575-04, TIME MEAN ALONGWIND CONCENTRATION=  .10189947-05
              TIME OF PASSAGE=  .36524491+02, AVERAGE ALONGWIND CONCENTRATION=  .16739366-04
** Y=   135.000, DOSAGE=  .28214210-03, CONCENTRATION=  .13252247-04, TIME MEAN ALONGWIND CONCENTRATION=  .47023684-06
              TIME OF PASSAGE=  .36522197+02, AVERAGE ALONGWIND CONCENTRATION=  .77252226-05
** Y=   140.000, DOSAGE=  .15557949-03, CONCENTRATION=  .73078598-05, TIME MEAN ALONGWIND CONCENTRATION=  .25929915-06
              TIME OF PASSAGE=  .36520875+02, AVERAGE ALONGWIND CONCENTRATION=  .42000153-05
** Y=   145.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   150.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   155.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000

                                              * X=    600.00 *
** Y=    54.000, DOSAGE=  .17599108+03, CONCENTRATION=  .82448182+01, TIME MEAN ALONGWIND CONCENTRATION=  .29331846+00
              TIME OF PASSAGE=  .36617448+02, AVERAGE ALONGWIND CONCENTRATION=  .46662981+01
** Y=   255.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   260.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   265.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   270.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   275.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   280.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   285.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   290.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   295.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   300.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   305.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   310.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   315.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   320.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
              TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   325.000, DOSAGE=  .21834503-06, CONCENTRATION=  .10256146-07, TIME MEAN ALONGWIND CONCENTRATION=  .36390838-09
              TIME OF PASSAGE=  .36520577+02, AVERAGE ALONGWIND CONCENTRATION=  .59786850-08
** Y=   330.000, DOSAGE=  .47801694-06, CONCENTRATION=  .22452872-07, TIME MEAN ALONGWIND CONCENTRATION=  .79669489-09
              TIME OF PASSAGE=  .36521608+02, AVERAGE ALONGWIND CONCENTRATION=  .13088606-07
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** Y=   335.000, DOSAGE=  .13772809-05, CONCENTRATION=  .64687796-07, TIME MEAN ALONGWIND CONCENTRATION=  .22954682-08
               TIME OF PASSAGE=  .36524980+02, AVERAGE ALONGWIND CONCENTRATION=  .37708845-07
** Y=   340.000, DOSAGE=  .49816824-05, CONCENTRATION=  .23395354-06, TIME MEAN ALONGWIND CONCENTRATION=  .83028039-08
               TIME OF PASSAGE=  .36527919+02, AVERAGE ALONGWIND CONCENTRATION=  .13638013-06
** Y=   345.000, DOSAGE=  .21499979-04, CONCENTRATION=  .10095576-05, TIME MEAN ALONGWIND CONCENTRATION=  .35833298-07
               TIME OF PASSAGE=  .36533007+02, AVERAGE ALONGWIND CONCENTRATION=  .58850832-06
** Y=   350.000, DOSAGE=  .10512416-03, CONCENTRATION=  .49353977-05, TIME MEAN ALONGWIND CONCENTRATION=  .17520694-06
               TIME OF PASSAGE=  .36539189+02, AVERAGE ALONGWIND CONCENTRATION=  .28770250-05
** Y=   355.000, DOSAGE=  .55354496-03, CONCENTRATION=  .25982939-04, TIME MEAN ALONGWIND CONCENTRATION=  .92257493-06
               TIME OF PASSAGE=  .36546277+02, AVERAGE ALONGWIND CONCENTRATION=  .15146412-04
** Y=      .000, DOSAGE=  .29920757-02, CONCENTRATION=  .14041565-03, TIME MEAN ALONGWIND CONCENTRATION=  .49867928-05
               TIME OF PASSAGE=  .36554255+02, AVERAGE ALONGWIND CONCENTRATION=  .81853454-04
** Y=     5.000, DOSAGE=  .15985722-01, CONCENTRATION=  .74533606-03, TIME MEAN ALONGWIND CONCENTRATION=  .26476204-04
               TIME OF PASSAGE=  .36562286+02, AVERAGE ALONGWIND CONCENTRATION=  .43448383-03
** Y=    10.000, DOSAGE=  .79634108-01, CONCENTRATION=  .37354601-02, TIME MEAN ALONGWIND CONCENTRATION=  .13272351-03
               TIME OF PASSAGE=  .36570721+02, AVERAGE ALONGWIND CONCENTRATION=  .21775372-02
** Y=    15.000, DOSAGE=  .36407772+00, CONCENTRATION=  .17074169-01, TIME MEAN ALONGWIND CONCENTRATION=  .60679620-03
               TIME OF PASSAGE=  .36579102+02, AVERAGE ALONGWIND CONCENTRATION=  .99531618-02
** Y=    20.000, DOSAGE=  .14735179+01, CONCENTRATION=  .69088383-01, TIME MEAN ALONGWIND CONCENTRATION=  .24558631-02
               TIME OF PASSAGE=  .36587176+02, AVERAGE ALONGWIND CONCENTRATION=  .40274162-01
** Y=    25.000, DOSAGE=  .51436169+01, CONCENTRATION=  .24135198+00, TIME MEAN ALONGWIND CONCENTRATION=  .85810267-02
               TIME OF PASSAGE=  .36594696+02, AVERAGE ALONGWIND CONCENTRATION=  .14669296+00
** Y=    30.000, DOSAGE=  .15213240+02, CONCENTRATION=  .71302065+00, TIME MEAN ALONGWIND CONCENTRATION=  .25355400-01
               TIME OF PASSAGE=  .36601435+02, AVERAGE ALONGWIND CONCENTRATION=  .41564599+00
** Y=    35.000, DOSAGE=  .37388113+02, CONCENTRATION=  .17529467+01, TIME MEAN ALONGWIND CONCENTRATION=  .62313522-01
               TIME OF PASSAGE=  .36607190+02, AVERAGE ALONGWIND CONCENTRATION=  .10213325+01
** Y=    40.000, DOSAGE=  .75442405+02, CONCENTRATION=  .35348675+01, TIME MEAN ALONGWIND CONCENTRATION=  .12573734+00
               TIME OF PASSAGE=  .36611784+02, AVERAGE ALONGWIND CONCENTRATION=  .20606044+01
** Y=    45.000, DOSAGE=  .12379918+03, CONCENTRATION=  .58001110+01, TIME MEAN ALONGWIND CONCENTRATION=  .20633197+00
               TIME OF PASSAGE=  .36615080+02, AVERAGE ALONGWIND CONCENTRATION=  .33810983+01
** Y=    50.000, DOSAGE=  .16414627+03, CONCENTRATION=  .76900121+01, TIME MEAN ALONGWIND CONCENTRATION=  .27357711+00
               TIME OF PASSAGE=  .36616977+02, AVERAGE ALONGWIND CONCENTRATION=  .44827912+01
** Y=    55.000, DOSAGE=  .17522587+03, CONCENTRATION=  .82089764+01, TIME MEAN ALONGWIND CONCENTRATION=  .29204312+00
               TIME OF PASSAGE=  .36617419+02, AVERAGE ALONGWIND CONCENTRATION=  .47853146+01
** Y=    60.000, DOSAGE=  .15047464+03, CONCENTRATION=  .70496295+01, TIME MEAN ALONGWIND CONCENTRATION=  .25079107+00
               TIME OF PASSAGE=  .36616391+02, AVERAGE ALONGWIND CONCENTRATION=  .41094886+01
** Y=    65.000, DOSAGE=  .10414995+03, CONCENTRATION=  .48796795+01, TIME MEAN ALONGWIND CONCENTRATION=  .17358325+00
               TIME OF PASSAGE=  .36613925+02, AVERAGE ALONGWIND CONCENTRATION=  .28445448+01
** Y=    70.000, DOSAGE=  .58376106+02, CONCENTRATION=  .27353492+01, TIME MEAN ALONGWIND CONCENTRATION=  .97293510-01
               TIME OF PASSAGE=  .36610095+02, AVERAGE ALONGWIND CONCENTRATION=  .15945358+01
** Y=    75.000, DOSAGE=  .26700894+02, CONCENTRATION=  .12513023+01, TIME MEAN ALONGWIND CONCENTRATION=  .44501340-01
               TIME OF PASSAGE=  .36605018+02, AVERAGE ALONGWIND CONCENTRATION=  .72943016+00
** Y=    80.000, DOSAGE=  .10075000+02, CONCENTRATION=  .47223283+00, TIME MEAN ALONGWIND CONCENTRATION=  .16791667-01
               TIME OF PASSAGE=  .36598847+02, AVERAGE ALONGWIND CONCENTRATION=  .27528190+00
** Y=    85.000, DOSAGE=  .31814961+01, CONCENTRATION=  .14915111+00, TIME MEAN ALONGWIND CONCENTRATION=  .53024935-02
               TIME OF PASSAGE=  .36591769+02, AVERAGE ALONGWIND CONCENTRATION=  .86945674-01
** Y=    90.000, DOSAGE=  .85621817+00, CONCENTRATION=  .40149727-01, TIME MEAN ALONGWIND CONCENTRATION=  .14270303-02
               TIME OF PASSAGE=  .36583999+02, AVERAGE ALONGWIND CONCENTRATION=  .23404171-01
** Y=    95.000, DOSAGE=  .20083095+00, CONCENTRATION=  .94192352-02, TIME MEAN ALONGWIND CONCENTRATION=  .33471825-03
               TIME OF PASSAGE=  .36575772+02, AVERAGE ALONGWIND CONCENTRATION=  .54908191-02
** Y=   100.000, DOSAGE=  .42176154-01, CONCENTRATION=  .19785732-02, TIME MEAN ALONGWIND CONCENTRATION=  .70293589-04
               TIME OF PASSAGE=  .36567339+02, AVERAGE ALONGWIND CONCENTRATION=  .11533832-02
** Y=   105.000, DOSAGE=  .81059955-02, CONCENTRATION=  .38411055-03, TIME MEAN ALONGWIND CONCENTRATION=  .13643326-04
               TIME OF PASSAGE=  .36558955+02, AVERAGE ALONGWIND CONCENTRATION=  .22391218-03
** Y=   110.000, DOSAGE=  .15231792-02, CONCENTRATION=  .71487756-04, TIME MEAN ALONGWIND CONCENTRATION=  .25386320-05
               TIME OF PASSAGE=  .36550876+02, AVERAGE ALONGWIND CONCENTRATION=  .41672851-04
** Y=   115.000, DOSAGE=  .28319395-03, CONCENTRATION=  .13293954-04, TIME MEAN ALONGWIND CONCENTRATION=  .47198992-06
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                 TIME OF PASSAGE=  .36543346+02, AVERAGE ALONGWIND CONCENTRATION=  .77495353-05
** Y=   120.000, DOSAGE=  .55071722-04, CONCENTRATION=  .25857656-05, TIME MEAN ALONGWIND CONCENTRATION=  .91786204-07
                 TIME OF PASSAGE=  .36536596+02, AVERAGE ALONGWIND CONCENTRATION=  .15073030-05
** Y=   125.000, DOSAGE=  .11766767-04, CONCENTRATION=  .55255576-06, TIME MEAN ALONGWIND CONCENTRATION=  .19611279-07
                 TIME OF PASSAGE=  .36530831+02, AVERAGE ALONGWIND CONCENTRATION=  .32210511-06
** Y=   130.000, DOSAGE=  .29078951-05, CONCENTRATION=  .13556910-06, TIME MEAN ALONGWIND CONCENTRATION=  .48464918-08
                 TIME OF PASSAGE=  .36526226+02, AVERAGE ALONGWIND CONCENTRATION=  .79611155-07
** Y=   135.000, DOSAGE=  .87527869-06, CONCENTRATION=  .41111129-07, TIME MEAN ALONGWIND CONCENTRATION=  .14587980-08
                 TIME OF PASSAGE=  .36522922+02, AVERAGE ALONGWIND CONCENTRATION=  .23965191-07
** Y=   140.000, DOSAGE=  .33724564-06, CONCENTRATION=  .15840977-07, TIME MEAN ALONGWIND CONCENTRATION=  .56207607-09
                 TIME OF PASSAGE=  .36521029+02, AVERAGE ALONGWIND CONCENTRATION=  .92342088-08
** Y=   145.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   150.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   155.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000

                                             * X=     700.00 *
** Y=    54.000, DOSAGE=  .17029139+03, CONCENTRATION=  .79701968+01, TIME MEAN ALONGWIND CONCENTRATION=  .28381898+00
                 TIME OF PASSAGE=  .36652377+02, AVERAGE ALONGWIND CONCENTRATION=  .46461212+01
** Y=   255.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   260.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   265.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   270.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   275.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   280.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   285.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   290.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   295.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   300.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   305.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   310.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   315.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   320.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
                 TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   325.000, DOSAGE=  .12759438-09, CONCENTRATION=  .59933849-11, TIME MEAN ALONGWIND CONCENTRATION=  .21265724-12
                 TIME OF PASSAGE=  .36520588+02, AVERAGE ALONGWIND CONCENTRATION=  .34937647-11
** Y=   330.000, DOSAGE=  .42394858-09, CONCENTRATION=  .19913026-10, TIME MEAN ALONGWIND CONCENTRATION=  .70658097-12
                 TIME OF PASSAGE=  .36521990+02, AVERAGE ALONGWIND CONCENTRATION=  .11608036-10
** Y=   335.000, DOSAGE=  .20300933-08, CONCENTRATION=  .95345469-10, TIME MEAN ALONGWIND CONCENTRATION=  .33834889-11
                 TIME OF PASSAGE=  .36525356+02, AVERAGE ALONGWIND CONCENTRATION=  .55580335-10
** Y=   340.000, DOSAGE=  .13027223-07, CONCENTRATION=  .61174973-09, TIME MEAN ALONGWIND CONCENTRATION=  .21712039-10
                 TIME OF PASSAGE=  .36530581+02, AVERAGE ALONGWIND CONCENTRATION=  .35661145-09
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        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   155.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
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                              ***** LAYER11 *****

                               ** INPUT DATA **

Q=  .19700000+04, UBAR AT BOTTOM= 11.9000, UBAR AT TOP= 13.0000, SIGAK AT BOTTOM= 1.00000, SIGAK AT TOP= 1.00000
SIGEK AT BOTTOM=  .95000, SIGEK AT TOP=  .95000, SIGXO=  93.0000, SIGYO=  93.0000, SIGZO= 115.4700, THETAK AT BOTTOM=240.0000
THETAK AT TOP=250.0000, Z= 1800.000, ALPHA=1.00, BETA=1.00, H=     .000, DELX=  .00000000   , DELY=  .00000000
IZMOD=1
 Z AT TOP= 2200.0000

CALCULATED INPUT PARAMETERS FOR MODELS 1,2,3 **** UBAR =  12.45900, THETA = 245.00000, DELTHP =  10.00000, DELU =   1.10000
, SIGAP =    .01656, SIGEP =    .01658
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   ** CALCULATION HEIGHT Z= 1800.000, CLOUD AXIS IS AT  65.000 DEGREES AZIMUTH BEARING RELATIVE TO ORIGIN

                                          * X=    500.00 *
** Y=    65.000, DOSAGE=  .33193886+00, CONCENTRATION=  .17719314-01, TIME MEAN ALONGWIND CONCENTRATION=  .55323142-03
        TIME OF PASSAGE=  .32135844+02, AVERAGE ALONGWIND CONCENTRATION=  .10329240-01
** Y=   255.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   260.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   265.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   270.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   275.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   280.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   285.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   290.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   295.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   300.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   305.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   310.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   315.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   320.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   325.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
        TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   330.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
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           TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   335.000, DOSAGE=  .00000000   , CONCENTRATION=  .00000000   , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
           TIME OF PASSAGE=  .00000000   , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   340.000, DOSAGE=  .27036516-06, CONCENTRATION=  .14430282-07, TIME MEAN ALONGWIND CONCENTRATION=  .45060860-09
           TIME OF PASSAGE=  .32120598+02, AVERAGE ALONGWIND CONCENTRATION=  .84171894-08
** Y=   345.000, DOSAGE=  .46175334-06, CONCENTRATION=  .24660407-07, TIME MEAN ALONGWIND CONCENTRATION=  .76958891-09
           TIME OF PASSAGE=  .32120945+02, AVERAGE ALONGWIND CONCENTRATION=  .14375459-07
** Y=   350.000, DOSAGE=  .94991716-06, CONCENTRATION=  .50730399-07, TIME MEAN ALONGWIND CONCENTRATION=  .15831953-08
           TIME OF PASSAGE=  .32121511+02, AVERAGE ALONGWIND CONCENTRATION=  .29572617-07
** Y=   355.000, DOSAGE=  .22906893-05, CONCENTRATION=  .12233151-06, TIME MEAN ALONGWIND CONCENTRATION=  .38178155-08
           TIME OF PASSAGE=  .32122279+02, AVERAGE ALONGWIND CONCENTRATION=  .71311542-07
** Y=      .000, DOSAGE=  .62789799-05, CONCENTRATION=  .33531150-06, TIME MEAN ALONGWIND CONCENTRATION=  .10464966-07
           TIME OF PASSAGE=  .32123226+02, AVERAGE ALONGWIND CONCENTRATION=  .19546542-06
** Y=     5.000, DOSAGE=  .18927803-04, CONCENTRATION=  .10107523-05, TIME MEAN ALONGWIND CONCENTRATION=  .31546338-07
           TIME OF PASSAGE=  .32124323+02, AVERAGE ALONGWIND CONCENTRATION=  .58920473-06
** Y=    10.000, DOSAGE=  .60648466-04, CONCENTRATION=  .32385301-05, TIME MEAN ALONGWIND CONCENTRATION=  .10108078-06
           TIME OF PASSAGE=  .32125536+02, AVERAGE ALONGWIND CONCENTRATION=  .18878565-05
** Y=    15.000, DOSAGE=  .19966803-03, CONCENTRATION=  .10661521-04, TIME MEAN ALONGWIND CONCENTRATION=  .33278005-06
           TIME OF PASSAGE=  .32126830+02, AVERAGE ALONGWIND CONCENTRATION=  .62149032-05
** Y=    20.000, DOSAGE=  .65355623-03, CONCENTRATION=  .34895993-04, TIME MEAN ALONGWIND CONCENTRATION=  .10892604-05
           TIME OF PASSAGE=  .32128164+02, AVERAGE ALONGWIND CONCENTRATION=  .20342159-04
** Y=    25.000, DOSAGE=  .20618133-02, CONCENTRATION=  .11008393-03, TIME MEAN ALONGWIND CONCENTRATION=  .34363555-05
           TIME OF PASSAGE=  .32129497+02, AVERAGE ALONGWIND CONCENTRATION=  .64171975-04
** Y=    30.000, DOSAGE=  .60920507-02, CONCENTRATION=  .32525247-03, TIME MEAN ALONGWIND CONCENTRATION=  .10153418-04
           TIME OF PASSAGE=  .32130791+02, AVERAGE ALONGWIND CONCENTRATION=  .18960164-03
** Y=    35.000, DOSAGE=  .16429339-01, CONCENTRATION=  .87712359-03, TIME MEAN ALONGWIND CONCENTRATION=  .27382232-04
           TIME OF PASSAGE=  .32132004+02, AVERAGE ALONGWIND CONCENTRATION=  .51130764-03
** Y=    40.000, DOSAGE=  .39535277-01, CONCENTRATION=  .21106229-02, TIME MEAN ALONGWIND CONCENTRATION=  .65892127-04
           TIME OF PASSAGE=  .32133101+02, AVERAGE ALONGWIND CONCENTRATION=  .12303598-02
** Y=    45.000, DOSAGE=  .83267855-01, CONCENTRATION=  .44451914-02, TIME MEAN ALONGWIND CONCENTRATION=  .13877976-03
           TIME OF PASSAGE=  .32134047+02, AVERAGE ALONGWIND CONCENTRATION=  .25912657-02
** Y=    50.000, DOSAGE=  .15108431+00, CONCENTRATION=  .80653285-02, TIME MEAN ALONGWIND CONCENTRATION=  .25180717-03
           TIME OF PASSAGE=  .32134815+02, AVERAGE ALONGWIND CONCENTRATION=  .47015770-02
** Y=    55.000, DOSAGE=  .23326883+00, CONCENTRATION=  .12452363-01, TIME MEAN ALONGWIND CONCENTRATION=  .38878139-03
           TIME OF PASSAGE=  .32135381+02, AVERAGE ALONGWIND CONCENTRATION=  .72589410-02
** Y=    60.000, DOSAGE=  .30378539+00, CONCENTRATION=  .16216575-01, TIME MEAN ALONGWIND CONCENTRATION=  .50630898-03
           TIME OF PASSAGE=  .32135727+02, AVERAGE ALONGWIND CONCENTRATION=  .94531979-02
** Y=    65.000, DOSAGE=  .33193886+00, CONCENTRATION=  .17719314-01, TIME MEAN ALONGWIND CONCENTRATION=  .55323142-03
           TIME OF PASSAGE=  .32135844+02, AVERAGE ALONGWIND CONCENTRATION=  .10329240-01
** Y=    70.000, DOSAGE=  .30378539+00, CONCENTRATION=  .16216575-01, TIME MEAN ALONGWIND CONCENTRATION=  .50630898-03
           TIME OF PASSAGE=  .32135727+02, AVERAGE ALONGWIND CONCENTRATION=  .94531979-02
** Y=    75.000, DOSAGE=  .23326883+00, CONCENTRATION=  .12452363-01, TIME MEAN ALONGWIND CONCENTRATION=  .38873139-03
           TIME OF PASSAGE=  .32135381+02, AVERAGE ALONGWIND CONCENTRATION=  .72589410-02
** Y=    80.000, DOSAGE=  .15108431+00, CONCENTRATION=  .80653285-02, TIME MEAN ALONGWIND CONCENTRATION=  .25180717-03
           TIME OF PASSAGE=  .32134815+02, AVERAGE ALONGWIND CONCENTRATION=  .47015770-02
** Y=    85.000, DOSAGE=  .83267855-01, CONCENTRATION=  .44451914-02, TIME MEAN ALONGWIND CONCENTRATION=  .13877976-03
           TIME OF PASSAGE=  .32134047+02, AVERAGE ALONGWIND CONCENTRATION=  .25912657-02
** Y=    90.000, DOSAGE=  .39535277-01, CONCENTRATION=  .21106229-02, TIME MEAN ALONGWIND CONCENTRATION=  .65892127-04
           TIME OF PASSAGE=  .32133101+02, AVERAGE ALONGWIND CONCENTRATION=  .12303598-02
** Y=    95.000, DOSAGE=  .16429339-01, CONCENTRATION=  .87712359-03, TIME MEAN ALONGWIND CONCENTRATION=  .27382232-04
           TIME OF PASSAGE=  .32132004+02, AVERAGE ALONGWIND CONCENTRATION=  .51130764-03
** Y=   100.000, DOSAGE=  .60920507-02, CONCENTRATION=  .32525247-03, TIME MEAN ALONGWIND CONCENTRATION=  .10153418-04
           TIME OF PASSAGE=  .32130791+02, AVERAGE ALONGWIND CONCENTRATION=  .18960164-03
** Y=   105.000, DOSAGE=  .20618133-02, CONCENTRATION=  .11008393-03, TIME MEAN ALONGWIND CONCENTRATION=  .34363555-05
           TIME OF PASSAGE=  .32129497+02, AVERAGE ALONGWIND CONCENTRATION=  .64171975-04
** Y=   110.000, DOSAGE=  .65355623-03, CONCENTRATION=  .34895993-04, TIME MEAN ALONGWIND CONCENTRATION=  .10892604-05
           TIME OF PASSAGE=  .32128164+02, AVERAGE ALONGWIND CONCENTRATION=  .20342159-04
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** Y=   115.000, DOSAGE=  .19966800-03, CONCENTRATION=  .10661524-04, TIME MEAN ALONGWIND CONCENTRATION=  .33278013-06
             TIME OF PASSAGE=  .32126830+02, AVERAGE ALONGWIND CONCENTRATION=  .62149940-05
** Y=   120.000, DOSAGE=  .60648466-04, CONCENTRATION=  .32385301-05, TIME MEAN ALONGWIND CONCENTRATION=  .10108078-06
             TIME OF PASSAGE=  .32125536+02, AVERAGE ALONGWIND CONCENTRATION=  .18878585-05
** Y=   125.000, DOSAGE=  .18927803-04, CONCENTRATION=  .10107523-05, TIME MEAN ALONGWIND CONCENTRATION=  .31546338-07
             TIME OF PASSAGE=  .32124323+02, AVERAGE ALONGWIND CONCENTRATION=  .58920473-06
** Y=   130.000, DOSAGE=  .62789799-05, CONCENTRATION=  .33531150-06, TIME MEAN ALONGWIND CONCENTRATION=  .10464966-07
             TIME OF PASSAGE=  .32123226+02, AVERAGE ALONGWIND CONCENTRATION=  .19546542-06
** Y=   135.000, DOSAGE=  .22907109-05, CONCENTRATION=  .12233267-06, TIME MEAN ALONGWIND CONCENTRATION=  .38178515-08
             TIME OF PASSAGE=  .32122279+02, AVERAGE ALONGWIND CONCENTRATION=  .71312217-07
** Y=   140.000, DOSAGE=  .94992480-06, CONCENTRATION=  .50730897-07, TIME MEAN ALONGWIND CONCENTRATION=  .15832080-08
             TIME OF PASSAGE=  .32121511+02, AVERAGE ALONGWIND CONCENTRATION=  .29572855-07
** Y=   145.000, DOSAGE=  .46175660-06, CONCENTRATION=  .24660581-07, TIME MEAN ALONGWIND CONCENTRATION=  .76959433-09
             TIME OF PASSAGE=  .32120945+02, AVERAGE ALONGWIND CONCENTRATION=  .14375561-07
** Y=   150.000, DOSAGE=  .27036643-06, CONCENTRATION=  .14439350-07, TIME MEAN ALONGWIND CONCENTRATION=  .45061071-09
             TIME OF PASSAGE=  .32120598+02, AVERAGE ALONGWIND CONCENTRATION=  .84172280-08
** Y=   155.000, DOSAGE=  .19497734-06, CONCENTRATION=  .10413113-07, TIME MEAN ALONGWIND CONCENTRATION=  .32496223-09
             TIME OF PASSAGE=  .32120481+02, AVERAGE ALONGWIND CONCENTRATION=  .60701873-08

                                                  * X=    600.00 *
** Y=    65.000, DOSAGE=  .32414349+00, CONCENTRATION=  .17299549-01, TIME MEAN ALONGWIND CONCENTRATION=  .54023914-03
             TIME OF PASSAGE=  .32142691+02, AVERAGE ALONGWIND CONCENTRATION=  .10084544-01
** Y=   255.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   260.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   265.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   270.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   275.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   280.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   285.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   290.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   295.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   300.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   305.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   310.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   315.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   320.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   325.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   330.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   335.000, DOSAGE=  .00000000    , CONCENTRATION=  .00000000    , TIME MEAN ALONGWIND CONCENTRATION=  .00000000
             TIME OF PASSAGE=  .00000000    , AVERAGE ALONGWIND CONCENTRATION=  .00000000
** Y=   340.000, DOSAGE=  .57807788-09, CONCENTRATION=  .30873121-10, TIME MEAN ALONGWIND CONCENTRATION=  .96346313-12
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                 TIME OF PASSAGE=  .32120659+02, AVERAGE ALONGWIND CONCENTRATION=  .17997079-10
** Y=   345.000, DOSAGE=  .13352252-08, CONCENTRATION=  .71309607-10, TIME MEAN ALONGWIND CONCENTRATION=  .22253753-11
                 TIME OF PASSAGE=  .32121149+02, AVERAGE ALONGWIND CONCENTRATION=  .41568413-10
** Y=   350.000, DOSAGE=  .40100510-08, CONCENTRATION=  .21415478-09, TIME MEAN ALONGWIND CONCENTRATION=  .66834183-11
                 TIME OF PASSAGE=  .32121964+02, AVERAGE ALONGWIND CONCENTRATION=  .12483829-09
** Y=   355.000, DOSAGE=  .15000167-07, CONCENTRATION=  .80104621-09, TIME MEAN ALONGWIND CONCENTRATION=  .25000279-10
                 TIME OF PASSAGE=  .32123979+02, AVERAGE ALONGWIND CONCENTRATION=  .46695933-09
** Y=      .000, DOSAGE=  .66655561-07, CONCENTRATION=  .35594225-08, TIME MEAN ALONGWIND CONCENTRATION=  .11109263-09
                 TIME OF PASSAGE=  .32124434+02, AVERAGE ALONGWIND CONCENTRATION=  .20749185-08
** Y=     5.000, DOSAGE=  .33404158-06, CONCENTRATION=  .17879734-07, TIME MEAN ALONGWIND CONCENTRATION=  .55806929-09
                 TIME OF PASSAGE=  .32126013+02, AVERAGE ALONGWIND CONCENTRATION=  .10422755-07
** Y=    10.000, DOSAGE=  .18091147-05, CONCENTRATION=  .96597119-07, TIME MEAN ALONGWIND CONCENTRATION=  .30151912-08
                 TIME OF PASSAGE=  .32127760+02, AVERAGE ALONGWIND CONCENTRATION=  .56310017-07
** Y=    15.000, DOSAGE=  .10014798-04, CONCENTRATION=  .53479634-06, TIME MEAN ALONGWIND CONCENTRATION=  .16691330-07
                 TIME OF PASSAGE=  .32129622+02, AVERAGE ALONGWIND CONCENTRATION=  .31169983-06
** Y=    20.000, DOSAGE=  .54251477-04, CONCENTRATION=  .28963997-05, TIME MEAN ALONGWIND CONCENTRATION=  .90419128-07
                 TIME OF PASSAGE=  .32131543+02, AVERAGE ALONGWIND CONCENTRATION=  .16684180-05
** Y=    25.000, DOSAGE=  .27564068-03, CONCENTRATION=  .14715136-04, TIME MEAN ALONGWIND CONCENTRATION=  .45940113-06
                 TIME OF PASSAGE=  .32133463+02, AVERAGE ALONGWIND CONCENTRATION=  .65779945-05
** Y=    30.000, DOSAGE=  .12641702-02, CONCENTRATION=  .67484085-04, TIME MEAN ALONGWIND CONCENTRATION=  .21069504-05
                 TIME OF PASSAGE=  .32135325+02, AVERAGE ALONGWIND CONCENTRATION=  .39338958-04
** Y=    35.000, DOSAGE=  .50597489-02, CONCENTRATION=  .27008543-03, TIME MEAN ALONGWIND CONCENTRATION=  .84329148-05
                 TIME OF PASSAGE=  .32137073+02, AVERAGE ALONGWIND CONCENTRATION=  .15744274-03
** Y=    40.000, DOSAGE=  .17166619-01, CONCENTRATION=  .91629565-03, TIME MEAN ALONGWIND CONCENTRATION=  .28611031-04
                 TIME OF PASSAGE=  .32138651+02, AVERAGE ALONGWIND CONCENTRATION=  .53414247-03
** Y=    45.000, DOSAGE=  .48183456-01, CONCENTRATION=  .25717597-02, TIME MEAN ALONGWIND CONCENTRATION=  .80305760-04
                 TIME OF PASSAGE=  .32140014+02, AVERAGE ALONGWIND CONCENTRATION=  .14991734-02
** Y=    50.000, DOSAGE=  .10970352+00, CONCENTRATION=  .58551575-02, TIME MEAN ALONGWIND CONCENTRATION=  .18283920-03
                 TIME OF PASSAGE=  .32141119+02, AVERAGE ALONGWIND CONCENTRATION=  .34131829-02
** Y=    55.000, DOSAGE=  .19956477+00, CONCENTRATION=  .10651000-01, TIME MEAN ALONGWIND CONCENTRATION=  .33260795-03
                 TIME OF PASSAGE=  .32141934+02, AVERAGE ALONGWIND CONCENTRATION=  .62088600-02
** Y=    60.000, DOSAGE=  .28697526+00, CONCENTRATION=  .15315960-01, TIME MEAN ALONGWIND CONCENTRATION=  .47829211-03
                 TIME OF PASSAGE=  .32142433+02, AVERAGE ALONGWIND CONCENTRATION=  .89282371-02
** Y=    65.000, DOSAGE=  .32414349+00, CONCENTRATION=  .17299589-01, TIME MEAN ALONGWIND CONCENTRATION=  .54023914-03
                 TIME OF PASSAGE=  .32142601+02, AVERAGE ALONGWIND CONCENTRATION=  .10084584-01
** Y=    70.000, DOSAGE=  .28697526+00, CONCENTRATION=  .15315960-01, TIME MEAN ALONGWIND CONCENTRATION=  .47829211-03
                 TIME OF PASSAGE=  .32142433+02, AVERAGE ALONGWIND CONCENTRATION=  .89282371-02
** Y=    75.000, DOSAGE=  .19956477+00, CONCENTRATION=  .10651000-01, TIME MEAN ALONGWIND CONCENTRATION=  .33260795-03
                 TIME OF PASSAGE=  .32141934+02, AVERAGE ALONGWIND CONCENTRATION=  .62088600-02
** Y=    80.000, DOSAGE=  .10970352+00, CONCENTRATION=  .58551575-02, TIME MEAN ALONGWIND CONCENTRATION=  .18283920-03
                 TIME OF PASSAGE=  .32141119+02, AVERAGE ALONGWIND CONCENTRATION=  .34131829-02
** Y=    85.000, DOSAGE=  .48183456-01, CONCENTRATION=  .25717597-02, TIME MEAN ALONGWIND CONCENTRATION=  .80305760-04
                 TIME OF PASSAGE=  .32140014+02, AVERAGE ALONGWIND CONCENTRATION=  .14991734-02
** Y=    90.000, DOSAGE=  .17166619-01, CONCENTRATION=  .91629565-03, TIME MEAN ALONGWIND CONCENTRATION=  .28611031-04
                 TIME OF PASSAGE=  .32138651+02, AVERAGE ALONGWIND CONCENTRATION=  .53414247-03
** Y=    95.000, DOSAGE=  .50597489-02, CONCENTRATION=  .27008543-03, TIME MEAN ALONGWIND CONCENTRATION=  .84329148-05
                 TIME OF PASSAGE=  .32137073+02, AVERAGE ALONGWIND CONCENTRATION=  .15744274-03
** Y=   100.000, DOSAGE=  .12641702-02, CONCENTRATION=  .67484085-04, TIME MEAN ALONGWIND CONCENTRATION=  .21069504-05
                 TIME OF PASSAGE=  .32135325+02, AVERAGE ALONGWIND CONCENTRATION=  .39338958-04
** Y=   105.000, DOSAGE=  .27564068-03, CONCENTRATION=  .14715136-04, TIME MEAN ALONGWIND CONCENTRATION=  .45940113-06
                 TIME OF PASSAGE=  .32133463+02, AVERAGE ALONGWIND CONCENTRATION=  .65779945-05
** Y=   110.000, DOSAGE=  .54251477-04, CONCENTRATION=  .28963997-05, TIME MEAN ALONGWIND CONCENTRATION=  .90419128-07
                 TIME OF PASSAGE=  .32131543+02, AVERAGE ALONGWIND CONCENTRATION=  .16684180-05
** Y=   115.000, DOSAGE=  .10014804-04, CONCENTRATION=  .53479634-06, TIME MEAN ALONGWIND CONCENTRATION=  .16691340-07
                 TIME OF PASSAGE=  .32129622+02, AVERAGE ALONGWIND CONCENTRATION=  .31170002-06
** Y=   120.000, DOSAGE=  .18091147-05, CONCENTRATION=  .96597119-07, TIME MEAN ALONGWIND CONCENTRATION=  .30151912-08
                 TIME OF PASSAGE=  .32127760+02, AVERAGE ALONGWIND CONCENTRATION=  .56310017-07
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APPENDIX E

METEOROLOGICAL AND SOURCE INPUTS

Meteorological and source model inputs used in the example calculations described in Section 6 are given in Tables E-1 through E-6. Tables E-1 and E-2 contain inputs respectively for the use of Model 4 and Model 3 in predicting concentration and dosage downwind from a normal launch during a sea-breeze meteorological regime at Kennedy Space Center. Model inputs for the use of Model 5 in predicting deposition due to precipitation scavenging and air concentration with depletion due to precipitation scavenging for a normal launch during a cold front passage at Kennedy Space Center are given in Table E-3. Table E-4 contains inputs for Model 6 for use in predicting deposition due to gravitational settling for a normal launch during a cold front passage at Kennedy Space Center. Finally, Tables E-5 and E-6 contain inputs respectively for the use of Model 4 and Model 3 in predicting concentration and dosage downwind from an on-pad abort during a post-cold front meteorological regime at Kennedy Space Center.

The source inputs in the tables were calculated using the procedures described in Section 6 of the report. Meteorological inputs of mean wind speed, and wind direction were obtained from the rawinsonde and NASA 150-Meter Ground Wind Tower profiles given in Section 6.

Values of the standard deviation of azimuth wind angle fluctuations at the reference height z_R $\left(\sigma_{AR}\{\tau_{oK}\}\right)$ were obtained from measurements made with bi-directional vanes when such information was available. When no measurements of this type were available, estimates based on climatology were made by experienced diffusion meteorologists. The following general rules were used to specify the vertical profiles of $\sigma_A\{\tau_{oK}\}$.

TABLE E-1

METEOROLOGICAL AND SOURCE INPUT PARAMETERS FOR MODEL 4 AND FOR A NORMAL LAUNCH DURING A SEA-BREEZE METEOROLOGICAL REGIME AT KENNEDY SPACE CENTER

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer				
					1	2	3	4	5
Q_K - HCl	ppm m^{+2}				1.44×10^5	3.49×10^5	9.66×10^5	2.27×10^6	4.55×10^6
z_R	m	2 m							
$\bar{u}_R$	m sec^{-1}		6.0						
$\bar{u}_{TK}$	m sec^{-1}				8.9	9.6	9.9	10.2	10.4
$\sigma_{AR}\{\tau_{oK}\}$	deg		8.0						
$\sigma_{ATK}\{\tau_{oK}\}$	deg				5.41	5.05	4.85	4.71	4.61
σ_{ER}	deg		7.6						
σ_{ETK}	deg				5.13	4.79	4.60	4.47	4.37
τ_K	sec			461					
τ_{oK}	sec	600 sec							
$\sigma_{xo}\{K\}$	m				14.9	44.7	74.4	104.2	134.0
$\sigma_{yo}\{K\}$	m				14.9	44.7	74.4	104.2	134.0
$\sigma_{zo}\{K\}$	m	$(z_{K+1}-z_K)/\sqrt{12}$							
α_K		1							
β_K		1							
z_{B1}	m	2							
z_{TK}	m				100	200	300	400	500

TABLE E-1

(Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 6	Layer 7	Layer 8	Layer 9	Layer 10	Layer 11
Q_K - HCl	ppm m^{+2}				7.77×10^6	1.13×10^7	1.39×10^7	9.61×10^6	5.40×10^5	1.07×10^3
z_R	m	2 m								
$\bar{u}_R$	m sec^{-1}		6.0							
$\bar{u}_{TK}$	m sec^{-1}				10.6	10.8	10.9	10.0	11.9	13.0
$\sigma_{AR}\{\tau_{oK}\}$	deg		8.0							
$\sigma_{ATK}\{\tau_{oK}\}$	deg				4.52	4.45	4.39	2.0	1.0	1.0
σ_{ER}	deg		7.6							
σ_{ETK}	deg				4.29	4.23	4.17	1.90	0.95	0.95
τ_K	sec			461						
τ_{oK}	sec	600 sec								
$\sigma_{xo}\{K\}$	m				163.7	193.5	223.3	182.8	93.0	93.0
$\sigma_{yo}\{K\}$	m				163.7	193.5	223.3	182.8	93.0	93.0
$\sigma_{zo}\{K\}$	m	$(z_{K+1}-z_K)/\sqrt{12}$								
α_K		1								
β_K		1								
z_{B1}	m	2								
z_{TK}	m				600	700	800	1300	1800	2200

TABLE E-1 (Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
θ_{B1}	deg				150				
θ_{TK}	deg				150	150	152	153	157
H_K	m								
x_{rz}	m	100 m							
x_{ry}	m	100 m							
x_{Rz}	m	0 m							
x_{Ry}	m	0 m							
Model No.		1			4	4	4	4	4
t*	sec	1 sec							
α_L (1)		α_K							
β_L (1)		β_K							
τ_L (1)	sec	τ_K							
τ_{oL} (1)	sec	τ_{oK}							
z_{RL} (1)	m	z_R							
$\bar{u}_{BL}$ (1)	m sec^{-1}	$\bar{u}_{BK}$							
$\bar{u}_{TL}$ (1)	m sec^{-1}	$\bar{u}_{TK}$							
$\sigma_{ABL}\{\tau_{oL}\}$ (1)	deg	$\sigma_{ABK}\{\tau_{oK}\}$							
$\sigma_{ATL}\{\tau_{oL}\}$ (1)	deg	$\sigma_{ATK}\{\tau_{oK}\}$							

(1) These parameters are for layer step change and the layer number should refer to the new layer structure where new layers are formed from two or more initial layers.

TABLE E-1 (Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer					
					6	7	8	9	10	11
θ_{B1}	deg									
θ_{TK}	deg				160	170	180	228	240	250
H_K	m									
x_{rz}	m	100 m								
x_{ry}	m	100 m								
x_{Rz}	m	0 m								
x_{Ry}	m	0 m								
Model No.		1			4	4	4	1	1	1
t*	sec	1 sec								
α_L (1)		α_K								
β_L (1)		β_K								
τ_L (1)	sec	τ_K								
τ_{oL} (1)	sec	τ_{oK}								
z_{RL} (1)	m	z_R								
$\bar{u}_{BL}$ (1)	m sec^{-1}	$\bar{u}_{BK}$								
$\bar{u}_{TL}$ (1)	m sec^{-1}	$\bar{u}_{TK}$								
$\sigma_{ABL}\{\tau_{oL}\}$ (1)	deg	$\sigma_{ABK}\{\tau_{oK}\}$								
$\sigma_{ATL}\{\tau_{oL}\}$ (1)	deg	$\sigma_{ATK}\{\tau_{oK}\}$								

(1) These parameters are for layer step change and the layer number should refer to the new layer structure where new layers are formed from two or more initial layers.

TABLE E-2

METEOROLOGICAL AND SOURCE INPUT PARAMETERS FOR MODEL 3 AND FOR A NORMAL LAUNCH DURING A SEA-BREEZE METEOROLOGICAL REGIME AT KENNEDY SPACE CENTER

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
Q_K - HCl	ppm m^{+2}				4.18×10^9				
z_R	m	2 m							
$\bar{u}_R$	m sec^{-1}		6.0						
$\bar{u}_{TK}$	m sec^{-1}				10.9				
$\sigma_{AR}\{\tau_{oK}\}$	deg		8.0						
$\sigma_{ATK}\{\tau_{oK}\}$	deg								
σ_{ER}	deg		7.6						
σ_{ETK}	deg								
τ_K	sec			461					
τ_{oK}	sec	600 sec							
$\sigma_{xo}\{K\}$	m				248				
$\sigma_{yo}\{K\}$	m				248				
$\sigma_{zo}\{K\}$	m	$(z_{K+1}-z_K)/\sqrt{12}$			116				
α_K		1							
β_K		1							
z_{B1}	m	2							
z_{TK}	m				800				

TABLE E-2 (Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
θ_{B1}	deg				150				
θ_{TK}	deg				180				
H_K	m				550				
x_{rz}	m	100 m							
x_{ry}	m	100 m							
x_{Rz}	m	0 m							
x_{Ry}	m	0 m							
Model No.		1			3				
t^*	sec	1 sec							
α_L ①		α_K							
β_L ①		β_K							
τ_L ①	sec	τ_K							
τ_{oL} ①	sec	τ_{oK}							
z_{RL} ①	m	z_R							
$\bar{u}_{BL}$ ①	m sec^{-1}	$\bar{u}_{BK}$							
$\bar{u}_{TL}$ ①	m sec^{-1}	$\bar{u}_{TK}$							
$\sigma_{ABL}\{\tau_{oL}\}$ ①	deg	$\sigma_{ABK}\{\tau_{oK}\}$							
$\sigma_{ATL}\{\tau_{oL}\}$ ①	deg	$\sigma_{ATK}\{\tau_{oK}\}$							

① These parameters are for layer step change and the layer number should refer to the new layer structure where new layers are formed from two or more initial layers.

TABLE E-3

METEOROLOGICAL AND SOURCE INPUT PARAMETERS FOR MODEL 5 (PRECIPITATION DEPOSITION) AND FOR A NORMAL LAUNCH DURING A COLD FRONT PASSAGE AT KENNEDY SPACE CENTER

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
Q_K - HCl Concentration	ppm m^{+2}				2.11×10^5	9.61×10^5	3.88×10^6	1.15×10^7	1.61×10^7
Q_K - HCl Deposition	mg m^{-1}				3.18×10^5	1.45×10^6	5.84×10^6	1.72×10^7	2.43×10^7
z_R	m	2 m	2						
$\bar{u}_R$	m sec^{-1}		7						
$\bar{u}_{TK}$	m sec^{-1}				10.5	11.3	11.9	12.4	12.7
$\sigma_{AR}\{\tau_{oK}\}$	deg		10						
$\sigma_{ATK}\{\tau_{oK}\}$	deg				6.61	6.17	5.89	5.65	5.49
σ_{ER}	deg		8.8						
σ_{ETK}	deg				5.82	5.43	5.18	4.97	4.83
τ_K	sec			317					
τ_{oK}	sec	600 sec							
$\sigma_{xo}\{K\}$	m				18.6	55.8	96.7	148.8	193.5
$\sigma_{yo}\{K\}$	m				18.6	55.8	96.7	148.8	193.5
$\sigma_{zo}\{K\}$	m	$(z_{K+1} - z_K)/\sqrt{12}$							
α_K		1							

TABLE E-3

(Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer					
					6	7	8	9	10	11
Q_K - HCl Concentration	ppm m^{+2}				9.15×10^{6}	2.08×10^{6}	1.87×10^{5}	6.59×10^{3}	9.01×10^{1}	4.69×10^{-1}
Q_K - HCl Deposition					1.38×10^{7}	3.13×10^{6}	2.81×10^{5}	9.93×10^{3}	1.36×10^{2}	7.07×10^{-1}
z_R	m	2 m	2							
$\bar{u}_R$	m sec^{-1}		7							
$\bar{u}_{TK}$	m sec^{-1}				13.0	13.2	13.4	13.6	13.8	14.0
$\sigma_{AR}\{\tau_{oK}\}$	deg		10							
$\sigma_{ATK}\{\tau_{oK}\}$	deg				5.37	5.27	5.19	5.12	5.06	5.01
σ_{ER}	deg		8.8							
σ_{ETK}	deg				4.73	4.64	4.57	4.51	4.46	4.41
τ_K	sec			317						
τ_{oK}	sec	600 sec								
$\sigma_{xo}\{K\}$	m				134.2	93	93	93	93	93
$\sigma_{yo}\{K\}$	m				134.2	93	93	93	93	93
$\sigma_{zo}\{K\}$	m	$(z_{K+1} - z_K)/\sqrt{12}$								
α_K		1								
β_K		1								

TABLE E-3 (Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
β_K		1							
z_{B1}	m	2							
z_{TK}	m				125	250	400	600	800
θ_{B1}	deg				41.0				
θ_{TK}	deg				44.5	48.0	49.0	51.0	54.0
H_K	m								
x_{rz}	m	100 m							
x_{ry}	m	100 m							
x_{Rz}	m	0 m							
x_{Ry}	m	0 m							
Model No.		1			5	5	5	5	5
t*	sec	1 sec							
α_L ①		α_K							
β_L ①		β_K							
τ_L ①	sec	τ_K							
τ_{oL} ①	sec	τ_{oK}							
z_{RL} ①	m	z_R							

① These parameters are for layer step change and the layer number should refer to the new layer structure where new layers are formed from two or more initial layers.

TABLE E-3 (Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer					
					6	7	8	9	10	11
z_{B1}	m	2								
z_{TK}	m				1000	1200	1400	1600	1800	2000
ϑ_{B1}	deg									
ϑ_{TK}	deg				59.0	66.0	73.5	80.0	86.5	91.0
H_K	m									
x_{rz}	m	100 m								
x_{ry}	m	100 m								
x_{Rz}	m	0 m								
x_{Ry}	m	0 m								
Model No.		1			5	5	5	5	5	5
t^*	sec	1 sec								
α_L (1)		α_K								
β_L (1)		β_K								
τ_L (1)	sec	τ_K								
τ_{oL} (1)	sec	τ_{oK}								
z_{RL} (1)	m	z_R								

(1) These parameters are for layer step change and the layer number should refer to the new layer structure where new layers are formed from two or more initial layers.

TABLE E-4

METEOROLOGICAL AND SOURCE INPUT PARAMETERS FOR MODEL 6 (GRAVITATIONAL DEPOSITION) AND FOR A NORMAL LAUNCH DURING A COLD FRONT PASSAGE AT KENNEDY SPACE CENTER

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
Q_K - Al_2O_3	mg				5.87×10^7	2.67×10^8	1.29×10^9	5.09×10^9	7.18×10^9
z_R	m	2 m							
$\bar{u}_R$	m sec^{-1}		7						
$\bar{u}_{TK}$	m sec^{-1}				10.5	11.3	11.9	12.4	12.7
$\sigma_{AR}\{\tau_{oK}\}$	deg		10						
$\sigma_{ATK}\{\tau_{oK}\}$	deg				6.61	6.17	5.89	5.65	5.49
σ_{ER}	deg								
σ_{ETK}	deg				5.82	5.43	5.18	4.97	4.83
τ_K	sec			317					
τ_{oK}	sec	600 sec							
$\sigma_{xo}\{K\}$	m				18.6	55.8	96.7	148.8	193.5
$\sigma_{yo}\{K\}$	m				18.6	55.8	96.7	148.8	193.5
$\sigma_{zo}\{K\}$	m	$(z_{K+1} - z_K)/\sqrt{12}$							
α_K		1							
β_K		1							
z_{B1}	m	2							
z_{TK}	m				125	250	400	600	800

TABLE E-4

(Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer					
					6	7	8	9	10	11
Q_K - Al_2O_3	mg				4.01×10^9	9.23×10^8	8.31×10^7	2.93×10^6	4.01×10^4	2.09×10^2
z_R	m	2 m								
$\bar{u}_R$	m sec^{-1}		7							
$\bar{u}_{TK}$	m sec^{-1}				13.0	13.2	13.4	13.6	13.8	14.0
$\sigma_{AR}\{\tau_{oK}\}$	deg		10							
$\sigma_{ATK}\{\tau_{oK}\}$	deg				5.37	5.27	5.19	5.12	5.06	5.01
σ_{ER}	deg									
σ_{ETK}	deg				4.73	4.64	4.57	4.51	4.46	4.41
τ_K	sec									
τ_{oK}	sec	600 sec								
$\sigma_{xo}\{K\}$	m				134.2	93	93	93	93	93
$\sigma_{yo}\{K\}$	m				134.2	93	93	93	93	93
$\sigma_{zo}\{K\}$	m	$(z_{K+1} - z_K)/\sqrt{12}$								
α_K		1								
β_K		1								
z_{B1}	m	2								
z_{TK}	m				1000	1200	1400	1600	1800	2000

TABLE E-4 (Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
θ_{B1}	deg				41.0				
θ_{TK}	deg				44.5	48.0	49.0	51.0	54.0
H_K	m								
x_{rz}	m	100 m							
x_{ry}	m	100 m							
x_{Rz}	m	0 m							
x_{Ry}	m	0 m							
Model No.		1			6	6	6	6	6
t*	sec	1 sec							
α_L ①		α_K							
β_L ①		β_K							
τ_L ①	sec	τ_K							
τ_{oL} ①	sec	τ_{oK}							
z_{RL} ①	m	z_R							
$\bar{u}_{BL}$ ①	m sec^{-1}	$\bar{u}_{BK}$							
$\bar{u}_{TL}$ ①	m sec^{-1}	$\bar{u}_{TK}$							
$\sigma_{ABL}\{\tau_{oL}\}$ ①	deg	$\sigma_{ABK}\{\tau_{oK}\}$							
$\sigma_{ATL}\{\tau_{oL}\}$ ①	deg	$\sigma_{ATK}\{\tau_{oK}\}$							

① These parameters are for layer step change and the layer number should refer to the new layer structure where new layers are formed from two or more initial layers.

TABLE E-4 (Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 6	Layer 7	Layer 8	Layer 9	Layer 10	Layer 11
θ_{E1}	deg									
θ_{TK}	deg				59.0	66.0	73.5	80.0	86.5	91.0
H_K	m									
x_{rz}	m	100 m								
x_{ry}	m	100 m								
x_{Rz}	m	0 m								
x_{Ry}	m	0 m								
Model No.		1			6	6	6	6	6	6
t^*	sec	1 sec								
α_L (1)		α_K								
β_L (1)		β_K								
τ_L (1)	sec	τ_K								
τ_{oL} (1)	sec	τ_{oK}								
z_{RL} (1)	m	z_R								
$\bar{u}_{BL}$ (1)	m sec^{-1}	$\bar{u}_{BK}$								
$\bar{u}_{TL}$ (1)	m sec^{-1}	$\bar{u}_{TK}$								
$\sigma_{ABL}\{\tau_{oL}\}$ (1)	deg	$\sigma_{ABK}\{\tau_{oK}\}$								
$\sigma_{ATL}\{\tau_{oL}\}$ (1)	deg	$\sigma_{ATK}\{\tau_{oK}\}$								

(1) These parameters are for layer step change and the layer number should refer to the new layer structure where new layers are formed from two or more initial layers.

TABLE E-4 (Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
σ_{EBL} ①	deg	σ_{EBK}							
σ_{ETL} ①	deg	σ_{ETK}							
θ_{BL} ①	deg	θ_{BK}							
θ_{TL} ①	deg	θ_{TK}							
V_s ②	m sec^{-1}			3×10^{-4}	1.4×10^{-3}	3.5×10^{-3}	1.4×10^{-3}	2.5×10^{-2}	4.8×10^{-2}
$f\{V_s\}$ ②				0.10	0.10	0.10	0.10	0.10	0.10
R									
V_{sK} ②	m sec^{-1}								
$f\{V_{sK}\}$ ②									
H_{sK}	m								
T_K	sec				1	1	1	1	1
Λ	sec^{-1}								

② These parameters are independent of the layers and the spaces are for their respective distribution.

TABLE E-4 (Continued)

Parameter	Units	Default Value	Atz_R Only	Common to all Layers	Layer 6	Layer 7	Layer 8	Layer 9	Layer 10	Layer 11
σ_{EBL} ①	deg	σ_{EBK}								
σ_{ETL} ①	deg	σ_{ETK}								
θ_{BL} ①	deg	θ_{BK}								
θ_{TL} ①	deg	θ_{TK}								
V_s ②	m sec^{-1}			3×10^{-4}	1.0×10^{-1}	2.5×10^{-2}	7.0×10^{-1}			
$f\{V_s\}$ ②				0.10	0.10	0.10	0.10			
R										
V_{sK} ②	m sec^{-1}									
$f\{V_{sK}\}$ ②										
H_{sK}	m									
T_K	sec				1	1	1	1	1	1
Λ	sec^{-1}									

② These parameters are independent of the layers and the spaces are for their respective distribution.

TABLE E-5

METEOROLOGICAL AND SOURCE INPUT PARAMETERS FOR MODEL 4 AND FOR AN ON-PAD ABORT DURING A POST-COLD FRONT METEOROLOGICAL REGIME AT KENNEDY SPACE CENTER

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer				
					1	2	3	4	5
Q_K - HCl	ppm m^{+2}				1.34×10^4	7.24×10^4	4.12×10^5	2.53×10^6	1.10×10^7
z_R	m	2 m	18						
$\bar{u}_R$	m sec^{-1}		6.0						
$\bar{u}_{TK}$	m sec^{-1}				8.2	9.0	9.6	10.0	11.0
$\sigma_{AR}\{\tau_{oK}\}$	deg								
$\sigma_{ATK}\{\tau_{oK}\}$	deg				6.69	6.02	5.55	5.18	4.93
σ_{ER}	deg		8.5						
σ_{ETK}	deg				6.32	5.68	5.24	4.89	4.65
τ_K	sec			450					
τ_{oK}	sec	600 sec							
$\sigma_{xo}\{K\}$	m				14.5	43.6	75.6	116.3	162.8
$\sigma_{yo}\{K\}$	m				14.5	43.6	75.6	116.3	162.8
$\sigma_{zo}\{K\}$	m	$(z_{K+1}-z_K)/\sqrt{12}$							
α_K		1							
β_K		1							
z_{B1}	m	2							
z_{TK}	m				125	250	400	600	1000

TABLE E-5

(Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 6	Layer 7	Layer 8	Layer 9	Layer 10	Layer 11
Q_K - HCl	ppm m^{+2}				2.74×10^7	3.93×10^7	3.26×10^7	1.24×10^7	1.34×10^6	
z_R	m	2 m	18							
$\bar{u}_R$	m sec^{-1}		6.0							
$\bar{u}_{TK}$	m sec^{-1}				11.0	11.0	10.4	8.6	6.0	
$\sigma_{AR}\{\tau_{oK}\}$	deg		9.0							
$\sigma_{ATK}\{\tau_{oK}\}$	deg				4.93	4.93	4.93	3.0	1.0	
σ_{ER}	deg									
σ_{ETK}	deg				4.65	4.65	4.65	2.83	0.94	
τ_K	sec			450						
τ_{oK}	sec	600 sec								
$\sigma_{xo}\{K\}$	m				209.3	270.7	224.2	166.0	96.3	
$\sigma_{yo}\{K\}$	m				209.3	270.7	224.2	166.0	96.3	
$\sigma_{zo}\{K\}$	m	$(z_{K+1} - z_K)/\sqrt{12}$								
α_K		1								
β_K		1								
z_{B1}	m	2								
z_{TK}	m				1000	1200	1400	1700	2000	

TABLE E-5 (Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
θ_{B1}	deg				80.0				
θ_{TK}	deg				80.5	82.0	80.0	78.0	75.0
H_K	m								
x_{rz}	m	100 m							
x_{ry}	m	100 m							
x_{Rz}	m	0 m							
x_{Ry}	m	0 m							
Model No.		1			4	4	4	4	4
t*	sec	1 sec							
α_L ①		α_K							
β_L ①		β_K							
τ_L ①	sec	τ_K							
τ_{oL} ①	sec	τ_{oK}							
z_{RL} ①	m	z_R							
$\bar{u}_{BL}$ ①	m sec^{-1}	$\bar{u}_{BK}$							
$\bar{u}_{TL}$ ①	m sec^{-1}	$\bar{u}_{TK}$							
$\sigma_{ABL}\{\tau_{oL}\}$ ①	deg	$\sigma_{ABK}\{\tau_{oK}\}$							
$\sigma_{ATL}\{\tau_{oL}\}$ ①	deg	$\sigma_{ATK}\{\tau_{oK}\}$							

① These parameters are for layer step change and the layer number should refer to the new layer structure where new layers are formed from two or more initial layers.

TABLE E-5 (Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 6	Layer 7	Layer 8	Layer 9	Layer 10	Layer 11
θ_{B1}	deg									
θ_{TK}	deg				71.0	65.0	57.0	40.5	9.0	
H_K	m									
x_{rz}	m	100 m								
x_{ry}	m	100 m								
x_{Rz}	m	0 m								
x_{Ry}	m	0 m								
Model No.		1			4	4	4	4	4	
t^*	sec	1 sec								
α_L ①		α_K								
β_L ①		β_K								
τ_L ①	sec	τ_K								
τ_{oL} ①	sec	τ_{oK}								
z_{RL} ①	m	z_R								
$\bar{u}_{BL}$ ①	m sec^{-1}	$\bar{u}_{BK}$								
$\bar{u}_{TL}$ ①	m sec^{-1}	$\bar{u}_{TK}$								
$\sigma_{ABL}\{\tau_{oL}\}$ ①	deg	$\sigma_{ABK}\{\tau_{oK}\}$								
$\sigma_{ATL}\{\tau_{oL}\}$ ①	deg	$\sigma_{ATK}\{\tau_{oK}\}$								

① These parameters are for layer step change and the layer number should refer to the new layer structure where new layers are formed from two or more initial layers.

TABLE E-6

METEOROLOGICAL AND SOURCE INPUT PARAMETERS FOR MODEL 3 AND FOR AN ON-PAD ABORT DURING A POST-COLD FRONT METEOROLOGICAL REGIME AT KENNEDY SPACE CENTER

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer				
					1	2	3	4	5
Q_K - HCl	ppm m^{+2}				2.22×10^{10}				
z_R	m	2 m	2						
$\bar{u}_R$	m sec^{-1}		6.0						
$\bar{u}_{TK}$	m sec^{-1}				10.4				
$\sigma_{AR}\{\tau_{oK}\}$	deg		9.0						
$\sigma_{ATK}\{\tau_{oK}\}$	deg				4.93				
σ_{ER}	deg		8.5						
σ_{ETK}	deg				4.65				
τ_K	sec								
τ_{oK}	sec	600 sec							
$\sigma_{xo}\{K\}$	m				263				
$\sigma_{yo}\{K\}$	m				263				
$\sigma_{zo}\{K\}$	m	$(z_{K+1}-z_K)/\sqrt{12}$			194				
α_K		1							
β_K		1							
z_{B1}	m	2							
z_{TK}	m				1400				

TABLE E-6 (Continued)

Parameter	Units	Default Value	At z_R Only	Common to all Layers	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
θ_{B1}	deg				80.0				
θ_{TK}	deg				57.0				
H_K	m				983				
x_{rz}	m	100 m							
x_{ry}	m	100 m							
x_{Rz}	m	0 m							
x_{Ry}	m	0 m							
Model No.		1			3				
t*	sec	1 sec							
α_L ①		α_K							
β_L ①		β_K							
τ_L ①	sec	τ_K							
τ_{oL} ①	sec	τ_{oK}							
z_{RL} ①	m	z_R							
$\bar{u}_{BL}$ ①	m sec^{-1}	$\bar{u}_{BK}$							
$\bar{u}_{TL}$ ①	m sec^{-1}	$\bar{u}_{TK}$							
$\sigma_{ABL}\{\tau_{oL}\}$ ①	deg	$\sigma_{ABK}\{\tau_{oK}\}$							
$\sigma_{ATL}\{\tau_{oL}\}$ ①	deg	$\sigma_{ATK}\{\tau_{oK}\}$							

① These parameters are for layer step change and the layer number should refer to the new layer structure where new layers are formed from two or more initial layers.

In the surface mixing layer $(z < H_m)$:

(1) If the wind speed is constant or decreases with height in the layer, $\sigma_A\{\tau_{oK}\}$ is held constant with height in the layer

(2) If the wind speed increases with height, $\sigma_A\{\tau_{oK}\}$ is decreased with height according to the relationship

$$\sigma_A\{\tau_{oK}, z\} = \sigma_{AR}\{\tau_{oK}\} \left(\frac{z}{z_R}\right)^{-p} \quad \text{(E-1)}$$

where

p = wind profile exponent

$$= \frac{\ell n \left[\bar{u}_{TK}/\bar{u}_R\right]}{\ell n \left[z_{TK}/z_R\right]} \quad \text{(E-2)}$$

$\bar{u}_{TK}$ = mean wind speed at the top of the layer z_{TK}

$\bar{u}_R$ = mean wind speed at the reference height z_R

In layers above the surface mixing layer $(z > H_m)$:

(1) If the wind speed is constant or decreases with height in a stable layer, $\sigma_A\{\tau_{oK}\}$ is decreased linearly with height from the value at the base of the layer to a value of one degree at the top of the layer

(2) If the wind speed is constant or decreases with height in the unstable layer, $\sigma_A\{\tau_{oK}\}$ is held constant with height in the layer

(3) If the wind speed increases with height in an unstable or stable layer, $\sigma_A\{\tau_{oK}\}$ is decreased with height according to the relationship

$$\sigma_A\{\tau_{oK}, z\} = \sigma_{ABK}\{\tau_{oK}\}\left(\frac{z}{z_{BK}}\right)^{-p_K} \quad \text{(E-3)}$$

where

$$p_K = \frac{\ell n\left[\bar{u}_{TK}/\bar{u}_{BK}\right]}{\ell n\left[z_{TK}/z_{BK}\right]} \quad \text{(E-4)}$$

$\bar{u}_{BK}$ = mean wind speed at the base of the layer z_{BK}

It should be noted that $\sigma_A\{\tau_{oK}\}$ is not permitted to be less than one degree.

Values of the standard deviation of elevation wind angle fluctuations are set equal to $\sigma_A\{\tau_K\}$; that is,

$$\sigma_E = \sigma_A\{\tau_{oK}\}\left(\frac{\tau_K}{\tau_{oK}}\right)^{1/5} \quad \text{(E-5)}$$

where

τ_{oK} = reference time period over which $\sigma_A\{\tau_{oK}\}$ is measured

τ_K = source function time in the layer

In the calculations, τ_K was set equal to the time t_{SI} required for the exhaust cloud to reach stabilization which is given by the expression

$$t_{SI} = \pi/s^{1/2} \quad \text{(E-6)}$$

when the instantaneous cloud rise formula given by Equation (3-3) in the report is used. The values of the diffusion parameters α and β were set equal to unity in all cases.